THE WEEK'S EVENTS

Explosion Wrecks Dayton Plant

Blast in pipe gallery of disposal plant puts plant out of service

An unexplained explosion Nov. 12 seriously crippled the sewage disposal plant at Dayton, Ohio, and put it out of service for an indefinite period until repairs can be made. Damage is estimated at about $10,000.

The plant consists of six Imhoff tanks in two banks of three, connected by a covered pipe gallery at each end of which is a control room. The reinforced concrete gallery is 8 ft. wide and about 150 ft. long. The two control houses, about 25 ft. square, are built of brick and reinforced concrete.

Apparently the explosion took place within the pipe gallery. The pressure blew off the entire roof and part of the walls, which were broken up and scattered over the tank area. It also blew out the side walls of both control houses, permitting the roofs to drop down on the foundations. The tanks suffered only minor damage.

No explanation of blast

The gallery had been inspected only 50 minutes before the explosion without any unusual condition being detected. It carried 8-in. gas pipes and electric wires, the latter enclosed in metal conduits. No explanation has been advanced for either the apparent presence of gas in explosive quantities or for the spark that must have ignited the mixture.

The two men on duty when the explosion occurred were in the power plant at the time and escaped unhurt. Shop windows were shattered as much as 2½ miles distant, but surprisingly little of the glass covering sludge-drying beds adjacent to the tanks was damaged.

Gas from the tanks is collected for use in the power plant, fertilizer works, sludge drying beds, and for heating city and privately owned buildings in the vicinity. The normal output is 150,000 cu. ft. per day.

F. O. Eichelburger, city manager of Dayton, immediately procured WPA labor to clear away the debris preparatory to rebuilding the plant. M. W. Tatlock is manager of the plant.

ENR staff photo

WRECKAGE of the pipe gallery and control house at the Dayton sewage plant after an unexplained explosion Nov. 12. The picture shows a portion of the pipe gallery with the roof of the south control house in the background.

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Housing in Third Quarter 62 Per Cent Over 1937

Sixty-two per cent more dwelling units were constructed in the urban United States during the third quarter of 1938 than during the corresponding period of 1937, the Bureau of Labor Statistics reported Nov. 12. Construction of 77,785 dwelling units during the third quarter not only was a marked increase over last year but also represented an increase of 35 per cent over the second quarter of 1938.

Dwelling unit construction during the first half of 1938 was 1 per cent over the first half of 1937, but the marked increase in the third quarter put the first nine months of 1938 18 per cent ahead of the corresponding period of 1937.

The major part of the increase during the first quarter was in multi-family dwellings. This classification was 244 per cent over the third quarter of 1937 and 150 per cent ahead of the second quarter of 1938.

The Bureau of Labor Statistics estimates are based on building permit reports received from more than 2,100 cities having a population of about 60,500,000—88 per cent of the entire urban population of the United States.

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City Public Health Men Form Organization

At the Kansas City meeting Oct. 26 of the American Public Health Association a new organization of municipal engineers engaged in health work was formed. It is to meet prior to the main convention of APHA, like the Conference of State Sanitary Engineers.

The official name is Conference of Municipal Public Health Engineers. Joel I. Connolly, Chicago, is chairman, Aime Cousineau, Montreal, is vice-chairman and Alfred H. Fletcher, Memphis, Tenn., is secretary-treasurer. Sanitary and public health engineers in health, water, industrial and similarly related departments of cities and urban areas are eligible for membership.

New York Housing To Be In Slums

Enough projects have been built in outlying areas, planning commission says

In the future, all new housing developments of the New York City Housing Authority should be erected in slum areas of the city rather than in outlying cheap-land areas, the city planning commission notified the Mayor November 9. The commission said its future decisions on housing matters would be controlled by this policy. Enough new housing projects have now been built in outlying areas, the commission feels.

"The time has now come for replacing appropriately located obsolete areas with modern housing for low income groups, particularly where this can be accomplished within walking distance of the opportunities for employment."

Cost of utilities

"No one aware of the city's financial and physical problems," the commission says, "can fail to be disturbed by the problems which will inevitably arise if the process of building on vacant sites is continued too long . . . Such movements [of population] involve, in addition to the cost of the new living accommodations, direct charges for street improvement, utilities, recreation and educational facilities, and many other public services, most of which have long been in existence in the portions of the city to be abandoned. . . .

"The commission is of the opinion that it is both desirable and practicable at this time to make a start in the clearing of the city slums, and without prejudicing any particular case, gives notice that its consideration of future sites will be largely conditioned by this point of view. This will be true of private as well as of public projects. . . . Present activities are of the sort which is creating slums faster than any agency can eliminate them. For the present, the old areas ought to be used rather than progressively sapped by subsidized competition."

Amortization of land

The commission's report said that present demolition or closing of individual tenements to meet the slum clearance requirements of the federal housing act does not eliminate a slum neighborhood. "Only by wholesale demolition of block after block of slum buildings can the evil be removed."

The commission is not impressed by the argument that land costs are high in the slums. "While recognizing the limitations to action under the present law which requires amortization of a project in 60 years, it should be clear that land and improvements for public housing ought not to be thought of as amortizable on the same scale. . . . The land is being acquired for an indefinite term . . . and its amortization can quite as logically be spaced over a hundred years as, say 25. . . . The contrast between $1 and $10 a foot becomes a scarcely measurable difference if the period is a hundred or more years. And the land is being acquired by the public forever. . . ."

ENR staff photo

DE BESTE STUURLUI STAAN AAN WAL

A DUTCH PROVERB to the effect that "The best pilots stand on the shore" forms the motto of the Sidewalk Superintendents Club which was opened to the public at Rockefeller Center, New York City, Nov. 10.

At the site of the excavation for the new Holland House building, a 16-story structure being built as the newest part of Rockefeller Center, a bay is set into the fence from which the public may watch the excavation work, their view obstructed only by heavy screening. Charter membership cards in the sidewalk superintendents club are being issued to all who visit the observation post during the first week it is opened.

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Real Estate Men Urge Slum Locations

A resolution adopted by the National Association of Real Estate Boards in Milwaukee Nov. 12 asked that USHA projects be confined to slums or blighted areas.

Other resolutions adopted "seriously questioned" the wisdom of government housing, attacked preferential tax treatment for low-rent federal projects, charged that in some cases USHA was approving projects with facilities "far better than appeared advisable for this type of structure." The convention suggested that low rent housing projects provide "only minimum facilities necessary for health, safety, and public morals."

Test Case to Be Brought Against Trailer Camps

The city building inspector of Milwaukee is planning to bring a test suit against a trailer camp operator, charging violation of the city building code. The inspector will base his complaint on the fact that living rooms do not contain 120 sq.ft. or bedrooms 80 sq.ft., the legal minimum; that the trailers have no foundations, no toilet or water facilities, and no veneering as is required in the fire district. In addition, electric wiring does not conform to the code.

Trailer camp operators have contended that the trailers are vehicles, not dwellings, and are therefore exempt from the building code requirements.

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Standards Publications Are Consolidated

At present the standards adopted or tentatively adopted by the American Society for Testing Materials are scattered through a number of different publications. A.S.T.M. standards are published in a two-volume book published triennially, with supplements to each volume coming out every year. Tentative standards proposed or revised in a given year are published in Part I of

the Annual Proceedings, and the tentative standards are also published in an annual book.

In order to handle the increasing number of standards, and to give greater ease of reference, all these publications are to be consolidated into a single work, the executive committee of the A.S.T.M. has decided. Every three years, beginning in November 1939, a three-volume book of the A.S.T.M. standards and tentative standards will be published. Each year, a supplement to each of the volumes will be published.

Part I of the new publication will be devoted to metals, Part II to non-metallic construction materials, and Part III to non-metallic general materials. A.S.T.M. members will be entitled to receive, on their dues, any one part of the book and its supplements. They may receive any two parts by paying annually $1.50 and any three parts for an annual payment of $2.50.

Tentative standards will no longer be included in the Annual Proceedings, which, in future, will be published as a single volume of 1,300 to 1,400 pages. The annual book of A.S.T.M. tentative standards will no longer be published. The annual index to standards and tentative standards will be continued.

CONTRACTS AND CAPITAL

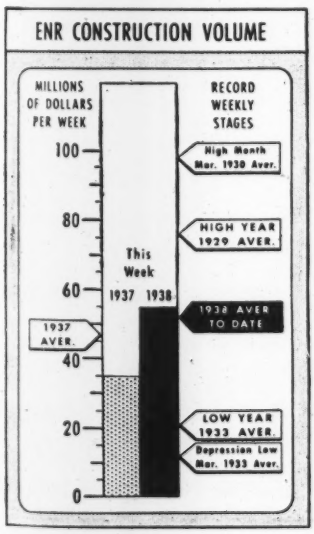
ENGINEERING construction awards for the week, $58,780,000, are 69 per cent above the volume for the corresponding 1937 week. Construction awards are above their 1937 values for the third successive week, and have fallen below the 1937 levels only once in the past 18 weeks.

Cumulative construction awards for 1938 to date total $2,402,711,000, a 10.9 per cent gain over the volume for the 46-week period in 1937.

Private construction is 1 per cent above the week a year ago, and public awards are 97 per cent higher than last year. High volume of public building and highway project lettings is responsible for the public gain.

Highway, public building, and earthwork and drainage volumes, although not near their highest levels of the year, are substantially above their 1937 values, and combined, make up 61 per cent of the week's total. In addition to these three classes of construction, waterworks, sewerage, bridges, commercial building and large-scale housing, and unclassified report gains over last year. All classes of construction are above their totals for the short preceding week.

New construction capital for the week totals $22,195,000, an increase of 138 per cent over the $9,315,000 reported last year. Cumulative construction financing for 46 weeks of 1938, $3,513,302,000, is 68 per cent higher than the volume reported for the corresponding period a year ago.



CONTRACTS

(Thousands of dollars)

	Week Ending Nov. 18 1937	Nov. 10 1938	Nov. 17 1938
Federal	$2,055	$5,803	$11,075
State & Municipal	22,600	26,149	37,510
Total public	$24,655	$31,952	$48,585
Total private	10,098	5,308	10,195
TOTALS	$34,753	$37,260	$58,780
Cumulative 1938 (46 weeks)			$2,402,711
1937 (46 weeks)			$2,166,109

Note: Minimum size projects included are: Waterworks and waterways projects, $15,000; other public works, $25,000; industrial buildings, $40,000; other buildings, $150,000.

NEW PRODUCTIVE CAPITAL

	Cumulative 1937 46 Wk.	1938 46 Wk.
NON-FEDERAL	$1,349,899	$2,369,607
Corporate securities	494,758	350,932
State & Mun. bonds	447,076	559,097
PWA loans, grants	178,126	825,185
RFC loans	29,939	100,344
U.S.H.A. loans	.....	265,054
R.E.A. loans	.....	67,495
Federal Aid-highways	200,000	201,500
FEDERAL	$746,223	$1,143,695
TOTAL CAPITAL	$2,096,122	$3,513,302

FHA MORTGAGES

	Week Ending Nov. 11 1937	Nov. 5 1938	Nov. 12 1938
Selected for appraisal	$7,912	$21,354	$16,380*
Cumulative 1938 (45 weeks)			$880,577*
1937 (45 weeks)			$536,876

* Subject to revision.

ENR INDEX NUMBERS

Index Base		1913	1926
Construction Cost	Nov.	234.40	112.69
Building Cost	Nov.	195.58	105.71
Volume	Oct.	217	95

Straus Sees Market For Private Housing

Neither government nor builders now serve third of urban families, he says

A third of the urban families in this country fall in a no-man's land of housing, U. S. Housing Administrator Straus told the annual meeting of the National Association of Real Estate Boards, Nov. 10. This group, with incomes ranging from $1,100 to $1,750 a year, is not served by government subsidized housing because its income is too high; and the private building industry has not found how to build for it, he said, because its income is too low.

Answering the fear of private builders that they will be subjected to damaging competition by the public housing program, Straus pointed out that a third of all urban families have an income of less than $1,100 per year and can afford rentals of less than $20 per month. USHA projects are intended to serve this group.

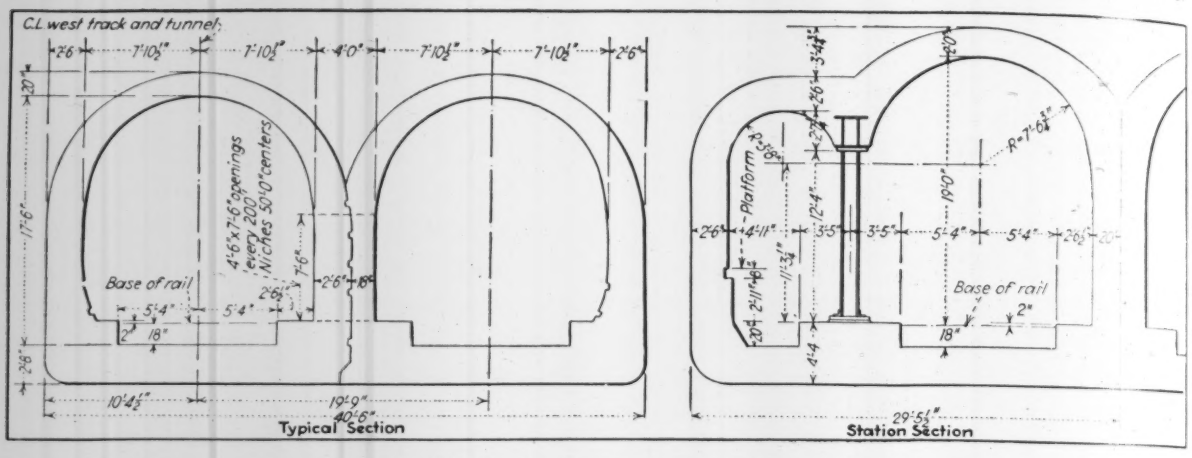
One-third of urban families have an income of more than $1,750 per year; they can afford to pay rent above $30 per month or buy a house costing $3,500 or more. This, Straus said, is the only group which is now being served by private industry.

Emphasizing that the public housing movement has stimulated interest in housing generally, both public and private, Straus said that the third of the population not now provided with any type of new housing, "constitutes the challenge to the private building industry".

"The private building industry today is building homes within reach only of about one out of three families of the population. It is doing one-third of a job, of which eventually it must do, in my belief, at least two-thirds."

Low cost achieved

In his talk before the real estate men, Straus attacked the belief that public housing is necessarily more costly than private housing. "Construction contracts actually awarded for the first USHA projects," he said, "show that the cost per dwelling unit will be lower than the average cost of private building construction in the same cities, as revealed by comparison with the published figures of the Bureau of Labor Statistics." Calculated by the bureau's methods, he pointed out, construction costs per dwelling for the two New York City projects will be about $2,900 and $3,400; costs of the Buffalo project will be about $3,600; of the Austin project, $2,300; and of the Jacksonville project, less than $2,900.



WHAT CHICAGO SUBWAYS WILL LOOK LIKE

ABOVE are typical cross sections which will be used in the new $40,000,000 subway system which Chicago is starting to build with the aid of a 45 per cent PWA grant.

Construction bids on the first section of the subway, on State St. between Illinois St. and Bellevue Place, will be opened Dec. 1.

D'Esposito Represents PWA On Chicago Subway

Joshua D'Esposito, who was a member of the special commission which examined the plans of Chicago's $40,000,000 subway project for PWA, has been appointed to represent PWA as resident project engineer on the subway work. He will continue to serve as resident project engineer on the Chicago sanitary district project.

D'Esposito, who is 59 years old, is a native of Italy. His first work in this country was as a draftsman in the chief engineer's office of the Pittsburgh Railway Co. from 1902 to 1904. He then joined the office of the Chief Engineer of the Pennsylvania lines west of Pittsburgh, rising to the rank of assistant engineer. In 1914 he became assistant chief engineer of the Chicago Union Station Co. and after service with the Emergency Fleet Corporation became chief engineer of the company in 1919. He held that post until 1927, when he resigned to take a consulting position with the company. In 1933 he was made PWA director of Illinois and a year later became project engineer on the $80,000,000 sanitary district project.

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Proposed Tenant Law Reduces Mexican Building

Dwelling house construction in the federal district of Mexico, which includes Mexico City, has decreased 27 to 30 per cent since the announcement that Congress is considering a new tenant law which will provide that no tenant can be dispossessed because of failure to pay rent, according to the Mexico City building construction workers union.

Permits for new buildings, most of them dwellings, which were granted in August totaled 230. In September, when the new law began to be discussed, the permits dropped to 168.

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Contractor Asks Damages For Defective Plans

The Hoard Engineering Co. of Seattle has filed suit in the county superior court at Olympia, Wash., against the state and against Washington State College, asking damages of $281,000 on the ground that plans for two buildings which the firm constructed on the college campus were so defective that it was impossible to follow them. The firm charges that the plans were not checked by the College Board of Regents and that the architectural and structural plans were not in agreement with each other. It alleges that the supervising architect refused to correct the plans.

The result, the company contends, was that the completed structures were entirely different from those which it contracted to construct and that much more than the estimated expense was involved.

The buildings were started in 1936 and have since been completed and accepted.

The attorney for the Board of Regents stated that the board checked the plans thoroughly. The plans were checked both by the college architect and by an independent Yakima architect, he said.

Roof Truss Blown Over At New York Airport

A 165-ft. 45,000-lb. roof truss which was being erected on one of the land plane hangars at the new North Beach airport under construction in Queens, New York City, was blown over by a sudden gust of wind Nov. 14 and fell to the ground, killing one workman and injuring five others.

The girder had been hoisted into place and bolted to its end support when the gust struck it, buckled it, and brought it to the ground. The girder pulled one of the end columns with it, breaking the column out of its concrete base. Six workmen were on the truss when it fell and were carried down.

The building is being erected as a WPA project. Colonel Brehon B. Somervell, New York City WPA Administrator, stated that he believes the wind stress caused the fall and said that he was "sure that it was no carelessness on the part of anyone connected with the work."

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New Medal Established For Building Inventions

A silver medal, known as the Frank T. Brown Medal, has been established by the Franklin Institute of Philadelphia to be awarded for "inventions and discoveries involving meritorious improvements in the building and allied industries." This is intended to include design and construction of buildings and equipment within the industry.

The medal is established by a fund left by Frank T. Brown, Philadelphia, plumbing contractor and manufacturer.

Housing Amendment Adopted in New York

Voters approve system of state loans to local governments for low-rent housing construction

A state program of loans and grants to local governments for public housing purposes, paralleling the federal program administered by the U. S. Housing Authority, was adopted by New York state voters Nov. 8 when they approved an amendment to the state constitution. Major feature of the amendment is a grant of authority to the state legislature to issue as much as $300,000,000 in bonds for low cost housing construction. The money would be loaned to local governments. Also authorized are annual subsidies by the state to reduce the rental on public housing projects. The legislature may increase the total annual subsidy by $1,000,000 each year up to a maximum of $5,000,000 annually.

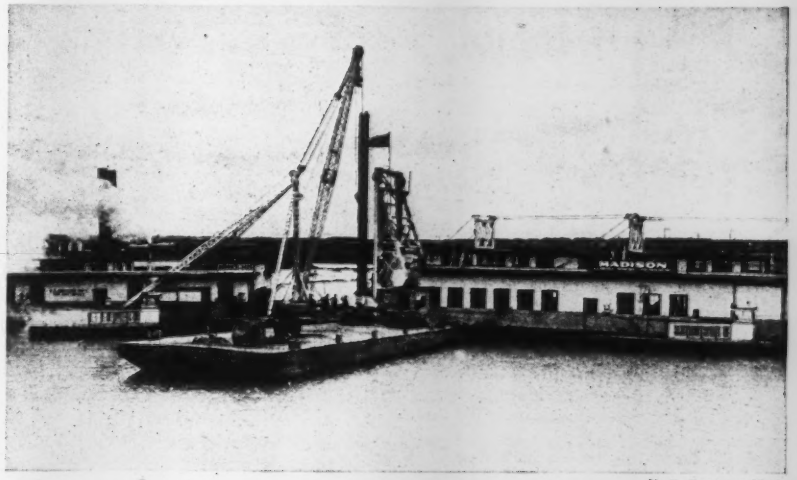
In order to permit local governments to take advantage of the state loans, the amendment also authorizes municipalities to borrow 2 per cent of their assessed valuation outside of the constitutional debt limit. A restriction is imposed that communities borrowing such funds must provide special taxes to meet the debt charges. The debt will be secured by the full credit of the community, but taxes on real estate can only be invoked if the special taxes prove insufficient.

Grade crossing elimination

Elimination of highway-railway grade crossings in New York state is expected to be expedited by another amendment adopted Nov. 8. Whereas in the past railways have had to pay 50 per cent of the cost of grade crossing elimination, under the constitutional amendment the railways will pay on the basis of benefit received from projects up to a maximum of 15 per cent of the total cost. Railroads will still pay all costs of incidental improvements which are of value only to the railroads, but will pay for no part of incidental highway improvements.

Another amendment adopted by New York voters provides that contractors on state public works must not work their men more than a 40-hr. week and must pay wages prevailing in the locality.

Also adopted was a constitutional amendment authorizing the city of New York to issue bonds totaling as much as $315,000,000 outside the constitutional debt limit to purchase the privately owned rapid transit lines in the city and achieve a unified transit system.



U. S. Engineer Photo

ANOTHER FORT PECK DREDGE SHUTS DOWN

DREDGING operations at the Fort Peck dam on the Missouri River were further reduced Nov. 7 when the Dredge Madison ceased operation and joined the Dredge Gallatin in winter quarters. Dredges Jefferson and Missouri are still operating and will carry the dredging season well into November in spite of the short period of cold weather which has been experienced. These two dredges are pumping fill into the protective dike on the upstream side of the section of the dam which was damaged in the slide of Sept. 22. Bulldozers are now sloping the upstream side of the dike.

The consulting board appointed to investigate the cause of the slide and to recommend reconstruction procedure met at the dam Nov. 15 to consider data obtained from borings and other investigations. The board's formal report is not expected to be completed for some time.

In the picture above, a derrick barge is seen removing one of the 75 ft. 22-ton spuds from the stern of the Madison. A second spud is out of sight. Both spuds were unshipped, preparatory to moving the dredge into the winter harbor, and placed on the barge which may be seen above with a dredge pump impellor and miscellaneous dredging equipment on it.

Adopted by Louisiana voters was a constitutional amendment providing exemption for three years from *ad valorem* taxes on new homes erected after Jan. 1, 1938. Also exempted from taxation are bridges across the Mississippi River owned by any state or political subdivision if they are operated toll free or if tolls are used to amortize the cost of the bridge. A third amendment authorizes the city of New Orleans and the Public Belt R. R. to construct a union station in New Orleans at an estimated cost of $15,000,000.

In Oregon, voters approved a 10-year program to provide sewage collection and treatment facilities on a pay-as-you-go basis. The plans involve construction of 28 miles of intercepting sewers along the Willamette River and an intercepting sewer along the Columbia Slough. A treatment plant will be built near the Columbia River. Work will be paid for by collection of a charge from sewer users equal to one-third the annual minimum water bill. Cost of the system is estimated at $10,000,000.

A proposition which would have levied a 3 cent gas tax to finance a 10-yr. highway construction program was defeated by Missouri voters. A 3 cent tax established by the legislature at the 1937 session was also defeated in a referendum last week.

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City Allowed to Operate Auto Testing Stations

The city of Water Valley, Miss., may legally own and operate an automobile testing station, a state court held Nov. 5 in denying an injunction sought in a taxpayer's suit.

The city had purchased equipment and obtained a permit to operate a testing station from the Mississippi Highway Safety Department, acting under the terms of a 1938 law. However, the assistant state attorney general recently delivered an opinion that a municipality had no direct authority to operate testing stations, and this raised such doubt as to the legality of the city's expenditure that the highway safety commissioner had a test suit brought. The case will be appealed to the state supreme court.

LABOR NOTES

PICKETING and boycotts by labor groups are drastically regulated by an initiative law passed by Oregon voters Nov. 8. The bill defines a labor dispute as one between an employer and a majority of his employees bearing only on wages, hours or conditions of labor. Picketing or boycotting any employer not involved in a labor dispute, as defined, is forbidden.

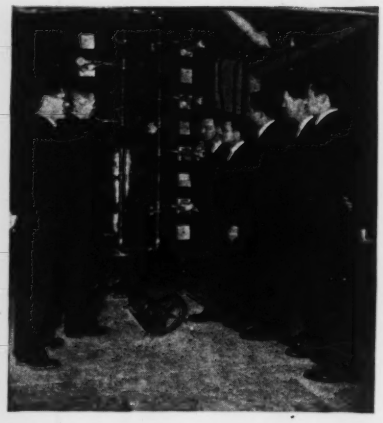
Similar, though somewhat less drastic, measures regulating labor disputes were defeated by the voters of Washington and California.

THREAT of a strike at the four plants of the St. Louis water department has arisen as a result of a dispute between two AFL unions there. The difficulty arose when four oilers employed by the water department dropped out of the Stationary Firemen, Oilers and Coal Passers Union and joined the Operating Engineers Union. At the request of the president of the oilers union, the four men were suspended by city officials, whereupon the operating engineers union threatened that if the men were not re-employed the 44 engineers employed in the city's water plant would be called out. The strike call has been postponed pending negotiations by international officers of the two unions involved.

LABOR DISPUTES on two parts of the Central Valley project in California reached differing conclusions early this month. A strike of the Pile Drivers, Bridge, Wharf and Dock Builders Union, AFL, against C. A. Dunn, contractor on the bridge across the Sacramento River for the relocation of the Southern Pacific lines at Shasta Dam, was terminated Oct. 31 when the contractor reached a closed shop agreement with the AFL group. Other demands won by the strikers included abolition of Sunday work except in an emergency, payment of two hours pay to workmen called to report and then not used, and clearer definitions of work classification.

Contractors on the Contra Costa conduit project, however, met a strike called by the Contra Costa Building and Construction Workers Council, AFL, to obtain improved wages and hours, by declaring the job open shop. The contractors said they expect to obtain CIO workmen for the job.

BUILDING construction in Juneau, Alaska, was halted early this month by a dispute between AFL and CIO as to jurisdiction over common labor.



EDUCATING CITY EMPLOYEES

DEAN THORNDIKE SAVILLE of the New York University College of Engineering and Prof. Lewis Van Carpenter explains to five of the New York City municipal employees who are now "career students" at the university, the operation of a new incinerator recently presented to the college. Under fellowships awarded by the city of New York, seven municipal employees are now studying and doing research in sanitary engineering at the college.

THE KENTUCKY Supreme Court early this month refused to review a court of appeals decision denying extra wages to workmen employed on a sewer project by the Northern States Contracting Co. and the Swords-McDougal Co. The workmen claimed that the sewer contract specified a schedule of wages to be paid and that the contractors had paid them as unskilled workmen whereas they should have received the skilled rate. The court of appeals found that the men had accepted checks in full payment for the work and had not protested to the Board of Labor Review.

THE MORRISON-KNUDSEN Co. of Boise, Idaho, has signed a contract with the AFL covering work on the Roza diversion dam which the company is building near Yakima, Wash., for the Reclamation Bureau.

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Court and Committee Study TVA

The Tennessee Valley Authority was put under scrutiny from two sources this week, as the U. S. Supreme Court began to hear arguments in the case being brought by 15 utility companies seeking to have the TVA's power activities declared unconstitutional on Nov. 14. The next day, the joint congressional committee investigating the Authority resumed hearings at Washington. The committee which closed its Knoxville hearing two and a half months ago, will hear testimony from private utility interests. TVA witnesses testified at the Knoxville hearing. Since hearings were terminated, the committee's legal, engineering and accounting staff has been gathering evidence.

OBITUARY

EDWARD L. BANDY, PWA engineer at Bruceton, Tenn., died there Nov. 7 at the age of 55. A graduate of Ohio State University, Bandy worked for six years in the Panama Canal Zone, practiced for some years in Memphis in partnership with Joseph P. Carey, and later was district highway engineer in Arkansas and Louisiana.

IRA C. OTIS, 77, locating engineer for the Washington state highway department, died in Seattle Nov. 2.

GEORGE M. SAVAGE, retired Tacoma contractor, died there Nov. 11 at the age of 73. In Tacoma since 1884, Savage had built many miles of streets and sidewalks there and was active in the early development of Tacoma's municipal hydro-electric system.

JOHN A. MURPHY, junior partner in the Ottawa contracting firm of Murphy Bros., died there Nov. 6, age 57.

MARSHALL C. MERRILLS, 47, Belleville, Mo., contractor, died there Nov. 11. Merrills graduated from the engineering school of the University of Illinois in 1914, served in the Army, and after five years with the Southern Coal Co., went into the contracting business in 1923.

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Water Supply Blamed For Gastro-enteritis

Milwaukee's water supply is a "probable" cause of the recurring epidemics of gastro-enteritis in that city, according to a report submitted by investigators for the federal health service. H. W. Streeter, federal sanitary engineer, headed the investigation.

The federal health service was called in to make an investigation after sharp disagreement had developed between Milwaukee's health commissioner, John T. Koerler, and the Wisconsin state health department. The state department was of tthe opinion that the disease was caused by pollution of the water supply, whereas Commissioner Koerler absolved the water and considered that the disease was air-borne.

COMMENT AND DISCUSSION

Readers' opinions on matters that concern the engineer

Fort Peck Slide

Sir: In your editorial comment on this unfortunate occurrence, featured on pp. 392 and 393 of your issue of Sept. 29, you use these words:

". . . the accident *belies* the expectation that scientific soil control in embankment building would do away with the risks of slides and slips, notorious threat to hydraulic fill dam construction. Careful control utilising all the resources of modern soil-mechanics procedure *was* applied in the Fort Peck work . . . (and) . . . the slip should be investigated . . . to *re-establish* scientific soil control as a dependable guide . . ." (Italics mine).

Is not this pre-judging the whole issue? It is well known that notable soil studies have been carried out at Fort Peck. Is it known, with equal certainty, that the soil experts on the engineering staff were allowed to apply their knowledge and research work to the design of the dam? In view of the comments still heard on occasion about "this new-fangled science of soil mechanics" is it not at least a possibility that soil studies were not applied to the design of the Fort Peck Dam as effectively as they might have been? Until all the facts about the slip are known and published, the "guilt" of soil mechanics in this instance is (to use an old term) "Not Proven."

ROBERT F. LEGGET
Asst. Prof. of Civil Engineering, University of Toronto, October 15, 1938

Arm Signals

Sir: The following arm signal numerals are much more convenient and advantageous than those mentioned by Milton A. Karp in your issue of Sept. 1, for the following reasons: The signals are not right and left, therefore no chance for confusion, as between his One and Four; a chain, rod, or other object need not be laid down in giving the signals; no need for the transit man to step so far away from the transit as with the two-arm signals.

One—Hand makes one quick dip from about shoulder high downward about a foot, and then back.

Two—Hand makes two dips as above.

Three—Hand strikes thigh or knee (rhymes with three).

Four—Hand strikes chest.

Five—Hand on top of head.

Six—Upper arm held horizontal, forearm pointing upward.

Seven—Whole arm horizontal.

Eight—Upper arm held horizontal, forearm pointing downward.

Nine—Hand swung to behind the back, belt high.

Zero—Upper arm horizontal, hand makes a circle.

MARK D. TAYLOR, JR.
Casper, Wyo.

Sewers in Quicksand

Sir: I read with interest Mr. Mirick's method of laying sewer pipe in quicksand which was outlined in your issue of Aug. 18.

About ten years ago the writer helped develop the following method, while working on a sewer job near Pontiac, Mich. It is probably cheaper than Mr. Mirick's method and under most conditions, just as good.

Quicksand was encountered while placing 42-in. reinforced concrete pipe about 22 ft. below the surface. As I recall it, the quicksand was about ten feet below the surface, and was topped by about four inches of water bearing sand. The ground was so treacherous that an open cut was made with a one and one-half foot dragline. The sand was stable enough to carry a man walking, if he kept walking. However, in cutting to grade the dragline bucket agitated the sand until it was almost impossible to get the pipe exactly to grade, and harder still to hold it there. After trying several other methods, the following one was developed and used:

The dragline cut down to within about three or four inches of grade, and the sand was shoveled out by hand from there to grade, the bottom of the ditch being shaped by hand to fit the pipe, giving it as much bearing surface as possible. A thin layer of dry marsh grass was then put down and the pipe laid on this. The pipe had to be eased carefully into place, so as not to agitate the sand. The grass seemed to absorb some of the water at the surface of the sand, making a stable surface on which to lay the pipe.

The last joint laid each night was checked with a wye level, and we never found one changed perceptibly over night. The line was "mooned" when the job was completed and was found to be all right. As far as I know this sewer is still in service.

J. E. MCDONALD
Junior Civil Engineer, U. S. Forest Service, Tellico Plains, Tenn.

Water Main Sterilization

In a recent article dealing with water main sterilization (*ENR* June 16, 1938 p. 854) there is a table giving the dosage of chlorinated lime and H T H (high-test hypochlorite) for various sizes of water mains. We noticed that the dosage for H T H was based upon 65 per cent available chlorine, and we would like to call to your attention the fact that our product contains 70 per cent available chlorine.

Thinking that you might wish to give the corrected figures for the H T H table, we have recalculated the dosage required for the various pipe sizes, and they are given in the accompanying table.

It can be seen from the corrected figures, that the use of the 70 per cent H T H would mean an appreciable saving where a great length of water main is to be sterilized and think that it is information that most engineers would be glad to have.

RALPH L. CORR,
The Mathieson Alkali Works, Inc.

Amount of Chlorine Compound Required For Sterilizing Various Sizes of Water Mains

Pipe Size	Lb. per 100 Ft.	Length Per Oz.	Length Per 6 Oz.
4 in.	0.038	150 ft.	900 ft.
6 in.	0.875	69 ft.	414 ft.
8 in.	0.155	39 ft.	234 ft.
10 in.	0.243	26 ft.	156 ft.
12 in.	0.35	17 ft.	102 ft.
16 in.	0.62	....	64 ft.
20 in.	0.975	....	39 ft.
24 in.	1.4	....	26 ft.

Spirals on Highway Curves

Sir: Your remarks on highway curves (June 23, p. 866) were very sensible. I have long waited for such an editorial. Try driving around a compounded curve, it is the hooey and unsafe.

AARON EVANS
Seattle, Wash., Sept. 12, 1938

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Editorial Offices at 330 West 42nd Street, New York

NOVEMBER 17, 1938

ONE OF THE STRAWS of the preelection campaign pointed to a growing understanding of road matters. Heretofore highway department patronage has figured in state campaigns, but a more worthy issue was raised in Maryland, where the rival candidates for Governor challenged each other on the efficiency of road administration. There were charges of wasting money in roadbuilding and maintenance and in allowing roads to deteriorate; whether or not they were true, the very fact that they were brought up shows that the road has become so commanding a part of the state's service to the public as to claim major place among campaign issues. This is significant because it means that public attention is being focussed on road expenditures, which in turn promises better planning and more efficient planning of roads. Once the taxpayer and voter comes to understand all about the highway dollar, its source in the road tax and its product in highway service, sound road policies will be assured.

New River Data

SHORTENING the Mississippi River by succeeding cutoffs made over a period of five years leaves few engineers unconvinced of the broad flood-control value of the work. Evidence has accumulated bit by bit as each river loop was amputated that a hydraulically sounder river channel was being produced, and finally the flood of 1937 proved the overall success of the surgical reconstruction. In an article that follows George R. Clemens of the Mississippi Commission tells of the development of the cutoffs in detail and of the final result of a 10 per cent or greater reduction in flood heights. No more successful operation in changing the water-carrying capacity of a great river has ever been recorded. But particularly, engineers have never had so complete details of the growth of cutoffs from pilot channels to full river capacities. In the early days of the shortening plan there was no conclusive evidence as to what the river might be expected to do in changing its century-old course with no more than a narrow dredge cut to influence the change. There were no quantitive data to be consulted. Today engineers have these data in magnificent proportions. Loop removal by river action can be planned as confidently as alluvial river hydraulics ever permits the engineer to plan.

Speaking of Sewers

AIR CONDITIONING and sewage treatment are bringing into sharp focus the deficiencies and obsolescence of existing sewer facilities. While the extra load from the discharge of air-conditioning waste water has overtaxed some sewers, it would be incorrect to lay the cause of all inadequacies to this source. Many of today's troubles can be traced to designs made at a time when future requirements could not be foreseen or provided for, so that later enlargement of sewer trunks is inevitable. Sewage treatment has likewise directed attention to sewer deficiencies, for it is costly to continue the use of an old and leaky system which permits the infiltration of groundwater and thus increases the flow to be handled at the plant. A current example is Janesville, Wis., which has been able to reduce sewer joint leakage by 5 m.g.d. Sewer modernization and extension is one of the major items on the Must list of improvements in municipal services. Though out of sight and therefore often out of mind, an efficient sewer system has more influence on community welfare and growth than many works of more obtrusive kind.

Meeting Competition in Speed

POWER AND SPEED are still kings in railroad operation. Delivery of a 6,000-hp. diesel-electric streamlined locomotive to the Seaboard Air Line for high-speed passenger service on Oct. 31 reemphasized the fact. Hope for operating economy may have been a factor in this purchase of ultramodern motive power by a railroad that is in receivership, but it probably was a very minor factor at best; the outstanding fact is that the traveling public wants more speed and likes to have it supplied in modern packaging—which incidentally fits the mechanical requirements of high-speed powering. The western streamliners have made a consistent record of good patronage, by all reports, indicating that they are a paying investment, and, as maintenance engineers were able to bring the track up to the more exacting service requirements of these trains without excessive cost so far as reported, the innovation has established itself securely in long-distance passenger transportation. On some important runs it yields the travelers a time-saving large enough to add a working day to their schedules—a convincing argument in the competition with airplane and automobile.

On present outlook a substantial extension of this type of high-speed service is in sight, and with it a rebuilding of the railroad's popularity as efficient and cheap passenger carrier.

Not Through Irrigation

NO READY SOLUTION can be found for the problem of the Great Plains, says the report of the Northern Great Plains Committee in effect. It pictures the problem in somber colors: A traditional seven years of drought visited the Dakotas, northern Nebraska and eastern Montana, and the resulting crop failures caused 20,000 families to give up and emigrate. Fundamental readjustment of land utilization, including partial return to grazing, is advocated, but the committee holds out strong hope that irrigation will be helpful. This recommendation in particular will interest engineers, in view of the record of disappointment in prior irrigation ventures in the region.

For half a century the possibilities of Great Plains irrigation have been a matter of speculation, hope and experiment. Optimists argued that irrigation would stabilize the uncertain agriculture and justify the destruction of the grazing industry. Pessimists said that the available water sources would not suffice. Thousands of farmers put the question to test by sinking wells, most of them since abandoned, and the Reclamation Service early built two large pump irrigation projects that later were shut down.

In the light of this record a proposal to use irrigation as a major aid in rehabilitating the northern Great Plains cannot be taken seriously. The fact is that for the region as a whole irrigation is out of the question because the water simply is not there. In a few small strips of land along perennial rivers it has possibilities, but it may fail in practice even here; experience has shown that in this semi-arid country, where in many years the natural moisture is sufficient for crops, the farmers will not pay for operating irrigation works during wet years, and by the time a drought year comes along the plant has become inoperative or at best has accumulated a prohibitive burden of standby costs.

Streams are few in the Plains, and their flow is not ample. To make these scanty waters useful for irrigation they must be stored, not merely from spring to midsummer, but from wet years to a later sequence of dry years. Practically speaking this is not feasible. Even on the Missouri—and there is only one Missouri—the huge storage volume in Fort Peck reservoir may not be able to provide for more than a few acres of riverside land under drought-sequence conditions. As concerns irrigation with pumped groundwater, available supplies are too small for more than a few farm patches.

In essence the Great Plains problem arises not so much from low rainfall as from variability of rainfall. Beginning with the first settlement of the region, when farmers cut up the open range and plowed up the sod, years of good rainfall and prosperity have been followed time and again by dry years and widespread distress. This inevitable sequence is the root of the problem. If irrigation could permanently solve it the undertaking would represent one of the most praiseworthy engineering tasks of the century. But even unlimited relief funds with which to build reservoirs, canals and pumping plants cannot bring non-existent waters to the Plains or enable irrigation works to take care of emergencies after lying unused for years.

In pointing out that the salvation of the northern Great Plains lies in the rebuilding of grazing and, to prepare for this, in public purchase of large blocks of land which through tax delinquency have proved unable to support permanent farming, the committee has made a large contribution to the subject. Early progress along the indicated course of action is urgently desirable. The startlingly high relief percentages cited by the committee are alone sufficient proof that something needs to be done quickly. It would be unfortunate therefore if the report should give rise to a belief that rehabilitation of the Plains can be attained by a large-scale irrigation development. The irrigation of the arid West cannot be transferred to the Plains.

Harmful Taxing System

THE TWENTIETH CENTURY FUND in a recent report on debt financing draws attention to a national taxing policy that is in part responsible for the present condition of the railroads and that can easily have a bad effect on other utilities —water, gas and electricity—if not changed.

The report points out that because income paid to stock holders in dividends is taxed as corporate income and is again taxed as personal income, while income paid as bond interest is not doubly taxed, the utilities are forced to resort to financing new work through bond issues in order to escape the higher taxes. This builds up a topheavy debt structure which is bad in many respects. From a construction viewpoint it results in quick curtailment of construction in the early days of any decline in business in order to conserve funds for bond interest.

With a relatively debt-free financial structure such quick curtailment of new work would not be necessary, as the cut could be made in stock dividends without seriously affecting the financial structure. Under these conditions improvement programs can be planned to cover a long period of years and can be carried forward despite minor fluctuations in general business conditions. Construction men should take an active interest in correcting a tax system that has such a direct effect in causing wide fluctuations in their own business.

Cutoffs Lower Flood Crests

GEORGE R. CLEMENS
Mississippi River Commission, Vicksburg, Miss.

Fifteen cutoffs are rapidly redistributing the flow of the Mississippi River and have materially lowered flood crests above Red River Landing

SINCE the first open record of the development and effect of shortening the Mississippi River by cutoffs was published in *ENR* Feb. 20, 1936, two years of accurate measurements have been made. In that period three more cutoffs have been opened up and the great flood of 1937 has come and gone as described by Major General J. L. Schley, Chief of Engineers, U.S.A., in *ENR*, April 14, 1938. How far have the cutoffs developed and how have they affected river flow in two years? (the first record was as of December, 1935; the present record is as of January, 1938). The answer is given in the striking illustrations and tabulations of vital facts contributed by Mr. Clemens in the following article.

It is a wonderful story of river engineering that this and the article of Feb. 20, 1936, by Mr. Clemens, spread before those who study the regimen of rivers. Contrary to the presumptions of years that change might not be dared, 331 mi. of sinuous river channel has been shortened 116 mi. How this bold venture came about was told in a series of articles in *ENR* beginning Jan. 22, 1933. But all this is now history. Our present interest is in the results that have followed channel shortening. They are given by two lines of a simple diagram on the opposite page. Simple as it is this diagram depicts one of the greatest revolutions in river flow that man has ever made.

EDITOR

IN THE LAST FIVE YEARS the Mississippi River has undergone a major operation of channel shortening. The first record of the steps in this operation and of its effect on river flow as determined up to Dec. 1, 1935, was published by the writer in *ENR*, Feb. 20, 1936. Observations for two more years up to February, 1938, have now been summarized and are given in this article.

Perhaps the first duty is to make clear the sources of the figures presented. They are based on careful measurements. More than 300 gages are read twice every week in a routine program and several hundred others are read during high-water periods. Large numbers of measurements of river flow are taken regularly and during the 1937 flood alone over 1,950 discharge observations were made. Weekly surveys of critical reaches of the river are made as required, and the entire river from Cairo, Ill., to Baton Rouge, La., about 850 mi., was sounded during the single low water season of 1937.

Since the previous summary (*ENR* Feb. 20, 1936) three additional cutoffs have been opened; they are: Rodney on Feb. 29, 1936; Sarah on March 23, 1936, and Caulk on May 13, 1937. A revised tabulation of cutoff lengths and shortening in the main river is given in the accompanying table. This shows a total shortening of 115.8 mi. at bankfull stage in the 330.6 mi. of river between Caulk and Glasscock. This does not include the shortening that has been obtained at a number of localities by developing chute, or secondary, channels to carry the main river flow. To keep the location of cutoffs in mind a map to December, 1937, is shown in Fig. 14.

A general description of all the cutoffs except the three new ones was given in the article of Feb. 20, 1936. Of course some changes have occurred in the older cuts but these are well enough indicated in the appendix that follows and only the new cuts will be described to make the record complete.

Rodney Cut—Rodney cut opened in February 1936 (Fig. 11) was constructed as were most of the latter cutoffs by dredging a pilot cut about 250 ft. wide to depths slightly below low water. About 2,500,000 cu.yd. were excavated in the pilot cut and about 2,000,000 cu.yd. have been removed at various times in improving

MISSISSIPPI RIVER CUTOFFS BETWEEN ARKANSAS RIVER AND RED RIVER LANDING

Mileages and Distance Refer to Center Line Bankfull River

Name of Cutoff	Date Opened	Location Upper End Cutoff River Mileage (a)	Distance in Miles as of date Cutoff opened			Length of Dredged Cut, ft.	Fall across Neck	
			Across Neck	Around Bend	Net Shortening		At High Water 1929, ft.	At Mean Low Water ft. (b)
Caulk	May 13, 1937	406.1	2.0	17.2	15.2	4,400	2.9 (c)	5.8 (d)
Ashbrook	Nov. 19, 1935	443.9	1.9	13.3	11.4	4,530	5.4	2.8
Tarpley	April 21, 1935	461.2	3.6	12.2	8.6	13,000	1.8	3.4
Leland	July 8, 1933	472.2	1.4	11.2	9.8	(f)	4.3	3.4
Worthington	Dec. 25, 1933	505.7	3.8	8.1	4.3	17,600	3.7	1.6
Sarah	Mar. 23, 1936	518.3	3.2	8.5	5.3	12,600	2.2	3.0
Willow	April 8, 1934	564.0	4.7	12.4	7.7	22,000	4.0	3.7
Marshall	Mar. 12, 1934	587.0	3.1	7.3	4.2	13,600	2.4	2.2
Diamond	Jan. 8, 1933	613.6	2.6	14.6	12.0	9,175	2.2	4.2
Yucatan	Fall of 1929	638.3	2.6	12.2	9.6	(e)	3.7	2.8
Rodney	Feb. 29, 1936	663.7	4.1	9.9	5.8	13,000	2.7	2.0
Giles	May 25, 1933	689.5	2.9	14.0	11.1	10,000	4.6	2.8
Glasscock	Mar. 26, 1933	722.5	4.8	15.6	10.8	20,800	3.2	3.4
Totals			40.7	156.5	115.8	155,605	43.1	41.1

(a) Below Cairo.
(b) As of date of opening Cutoff.
(c) 1937 high water fall = 4.7 feet.
(d) Actual fall on Aug. 28, 1936 = 10.6 ft. at low water.
(e) River broke into channel Big Black River.
(f) River broke into old blue hole.

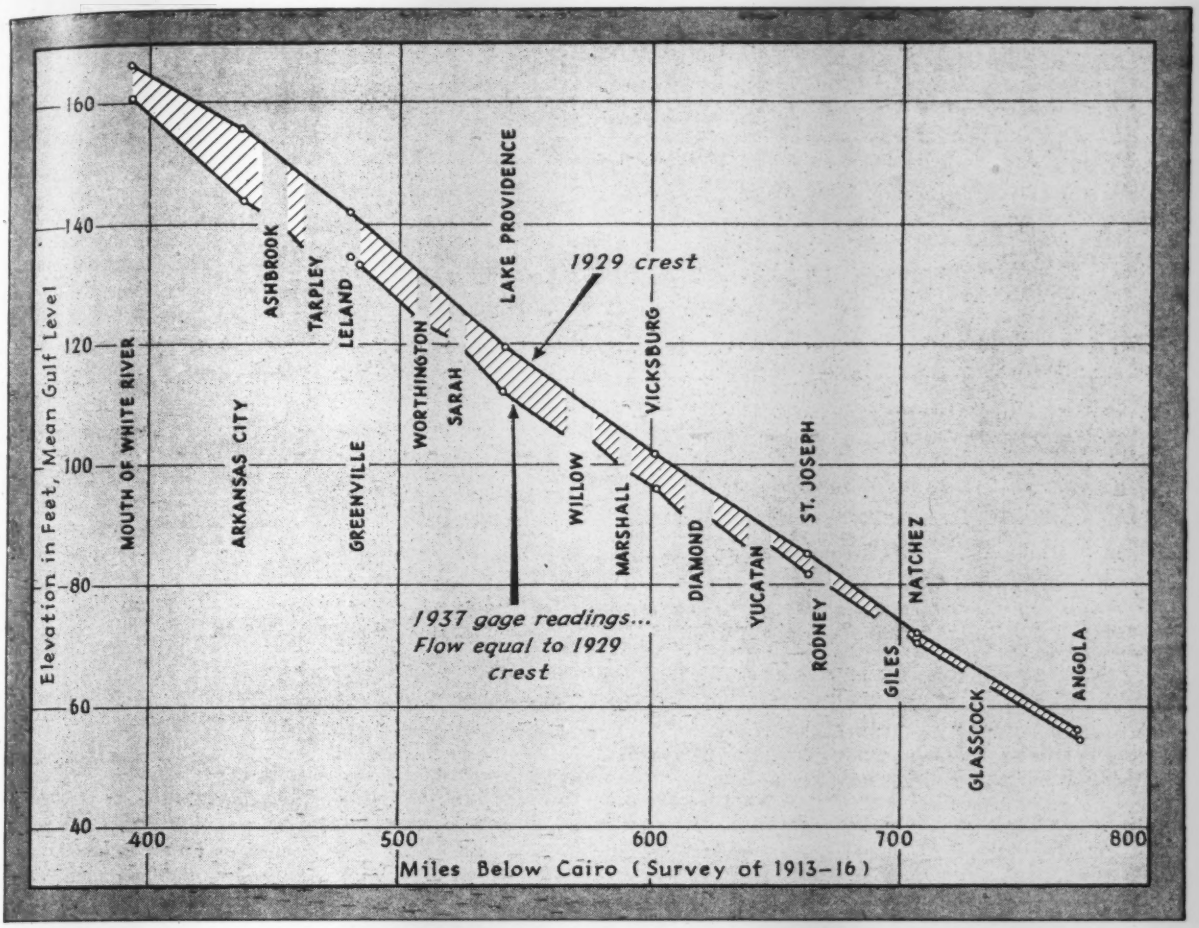


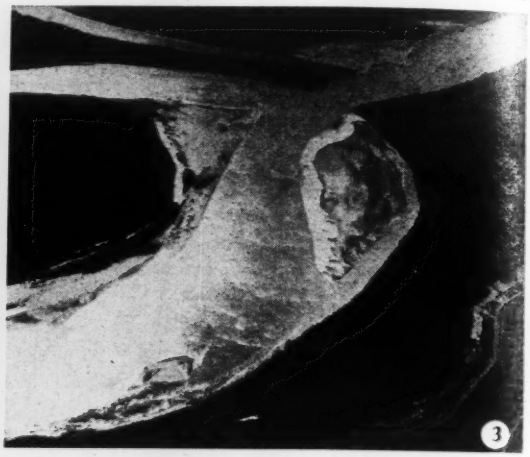
Fig. 1. Cutoffs have reduced crests of comparable Mississippi River floods as shown by the shaded zone.

the entrance and assisting the river in enlarging the pilot cut. The fall across the neck was relatively small and the development has not been extremely rapid although it has proceeded in a very satisfactory manner. The cut has deepened without excessive widening. Fig. 11 shows some closure of the old bendway channel by the sand bar above the cut but no evidence of a bar below the cut.

Sarah Cut—Sarah cut (Fig. 6) is located immediately below Cracraft chute; Worthington cut shows in the background, Cracraft chute immediately below it and directly across the river from Cracraft chute is Sarah cut. Below this cut in the right foreground is shown Opossum chute which is also being enlarged to carry the main river. In reality the entire reach, Worthington cut, Cracraft chute, Sarah cut and Opossum chute, form a single channel realignment project. About 4,500,000 cu.yd. were excavated in constructing the pilot cut at Sarah which was made in the conventional manner with cutter dredges. About 7,000,000 cu.yd. additional have been removed in enlarging this cut. As the fall across the neck was not great and the development of the cut has required the development of both Cracraft and Opossum chutes to keep pace with it, the enlargement dredging required has been relatively large. There has been considerable closure of the old bendway channel at the upper end of the cut by sand bars, as can be seen, and the blanket bar downstream from the cut has already closed off a part of the channel below the cut and has assisted in the development of Opossum chute.

Caulk Cut—Caulk cut is the last one made in the lower river. It is about 5 mi. downstream from the mouth of the Arkansas River and was opened following the 1937 high water on May 13, 1937. This cut shortened the river by 15.2 mi., and due in part to the lowering obtained by cutoffs below, it had the greatest drop across the neck of any cut attempted to the date of its opening. During 1936 low water the actual fall across this neck reached a maximum of 10.6 ft. At the time the cut was opened the actual fall was about 8 ft. The cut was constructed in the normal manner by dredging a pilot channel across the neck with a cutter dredge. About 1,500,000 cu.yd. were dredged during the months of April and May and in enlarging the pilot cut during the latter part of May and the first of June. During the balance of the low-water season the cut enlarged by natural erosion to such an extent that late in the fall season low-water navigation both up and downstream was routed through the cutoff. The pilot channel was cut only across the higher portion of the neck and the river itself scoured a channel across the bar comprising about the lower half of the neck. Fig. 2 shows the cutoff in September, 1937. Subsequent to taking this photograph the winding channel across the lower half

CAULK



ASHBROOK

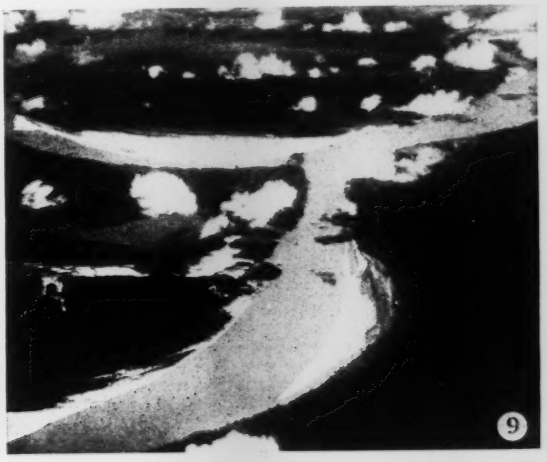
LELAND-TARPLEY

WORTHINGTON

SARAH

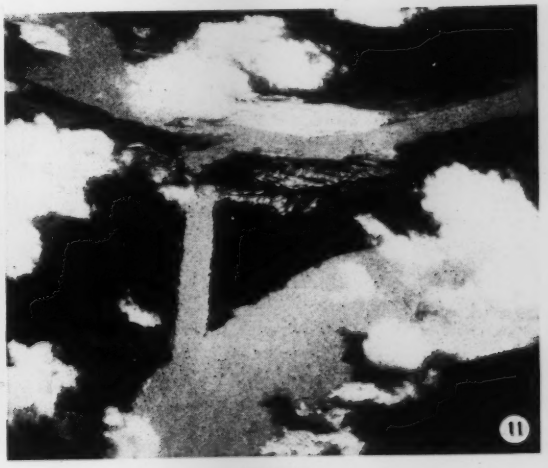
WILLOW

MARSHALL



DIAMOND

YUCATAN



RODNEY

GILES

GLASSCOCK

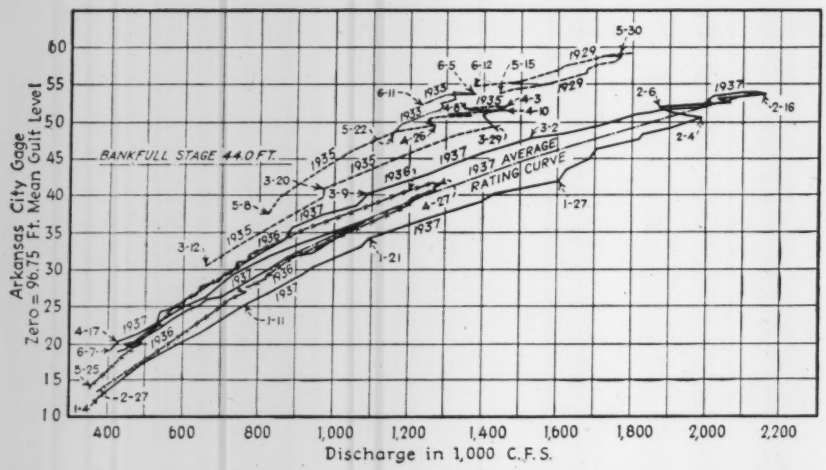


Fig. 13. Stage and discharge relations at Arkansas City of the 1937 and previous floods.

of the neck has straightened so that the alignment through the cutoff is practically straight. In the background may be seen the mouth of the Arkansas River.

From the preceding description of the cutoffs and discussion of their development in the following appendix a rather complete story of the changes that have occurred from the beginning of 1936 to the end of 1937 is obtained. What has been the effect of these changes on the river?

Comparison of flow lines

The varying sizes of different floods make it difficult to compare the effect that has been obtained on river flow line. Any true comparison must be based on floods of the same size.

To compare a horse with a colt would not furnish any measure of ability of the horse to win races. One could merely conclude that they were both horses. Many comparisons have been made of flood crests, and erroneous conclusions reached. As compared to the 1937 flood, the 1929 flood was a mere colt. Fig. 1 presents a comparison of the stages produced by a flow approaching the crest of the 1929 flood and the same flow during the 1937 flood. In other words, for two floods of the same size a material lowering has been obtained from Arkansas City to well below Vicksburg and a smaller lowering at Natchez.

Another way in which this same effect may be observed is to study the changes which have occurred in the relation between height of water and quantity of flow at various key points. A typical study is given on Fig. 13, showing this relation at Arkansas City, for measurements obtained in the river near that point. By comparing this chart with the stage lowering shown on Fig. 1, the flows at stages near the 1929 crest may be noted at about 12 ft. higher than the same flows in 1937. Even considering the average between rising and falling stages in 1937, the difference remains at about 10 ft.

From a study of the various information at hand it appears reasonable to conclude that in 1937 a lowering of from 9 to 12 ft. at Arkansas City, from 4 to 6 ft. at Vicksburg, and from 1 to 2 ft. at Natchez had been obtained for floods of like magnitude approximating a crest flow of 1,800,000 c.f.s. which is about nine times the flow of the Niagara River.

Summary

Observations to date show definite lowering of flow lines. The exact amount may be subject to some variation. The direction is positive. Any lowering of flow lines is a material benefit to the flood-control project. The 1937 flood was passed through the river between the Arkansas River and the Gulf without overtopping any of the main levees. Measurements show it reached a peak rate considerably above that assumed in 1927 as sufficient to overtop the so-called fuse plug levee and utilize the emergency overflow area in the Boeuf Basin. The improvement in river capacity was such as to accommodate the entire flow without the use of any overflow basin. This accomplishment alone would justify the cost of the work to date without allowing any benefit for the many smaller floods that have been lowered and the increased development of backwater areas and overflow lands which the cutoff and channel improvement work has produced.

APPENDIX

Development of Cutoffs

The most easily understood measure of cutoff enlargement is obtained by studying the percentage of the river flow each carries. Measurements of this flow have been made at frequent intervals since the cutoffs were opened. In Fig. 14 is shown the percentage of flow at low water and bank full stages indicating the development of the cuts by the end of 1937.

Four of the 13 cutoffs, namely, Ashbrook, Leland, Marshall, and Yucatan, carried 100 percent of the flow at low water but only Leland carried 100 percent at bank full stage. Two others—Tarpley and Willow—were almost fullsized at low water and Ashbrook, Tarpley and Yucatan carried the major portion of the bank full flow. From this study it is apparent that the cutoffs had not reached their full size by the end of 1937. About one-half of them had only developed to carry 50 per cent or less of the bank full flow.

A more detailed study of typical actual discharge measurements tells a graphic story of the manner in which the river has accepted each cutoff channel as its main course. The high lights of this story are given in the following short summaries:

GLASSCOCK

Low Water

Date	Natchez Gage Height in Ft.	Per cent of River Flow in Cutoff
10/11/35	5.9	1
7/22/36	6.0	12
12/13/37	5.9	40
12/20/37	3.2	42
	High Water	
5/ 3/33	49.6	2
4/13/34	37.4	
4/24/35	50.3	13
5/ 4/36	45.8	14
2/23/37	58.0	21
3/15/37	49.5	21

Glasscock cut was opened during the March rise in 1933. The discharge increased very slowly and only reached 2 per cent by the May crest. During 1933 low water the flow shut off. The 1934 rise carried about the same amount as 1933 and again closed off at low water. During the April 1935 high water the flow increased to 13 per cent for the 50-ft gage but in low water dropped back to 1 per cent for a 6-ft gage. The 1936 spring rise showed very little change from 1935 giving 14 per cent for a 45.8 gage. Low water, however, in 1936 built up to 12 per cent for the 6 ft gage and did not fall below 9 per cent for lower gage heights. The crest of the 1937 flood showed 21 per cent for the 58-ft gage and the same at the 50-ft gage. Low water in 1937 showed a marked increase to 40 per cent for a 6-ft gage, with a maximum of 42 per cent at a 3.2 gage.

GILES

Low Water

Date	Natchez Gage Height in Ft.	Per cent of River Flow in Cutoff
10/ 8/34	6.3	10
10/12/35	5.8	70
12/ 5/36	5.5	60
10/ 1/37	4.3	81
10/18/37	5.8	76
	High Water	
6/11/33	50.3	3
4/16/34	37.5	
4/23/35	50.3	20
5/ 2/36	46.1	53
2/25/37	58.0	57
3/13/37	51.4	42

Giles cut was opened during the May highwater of 1933. Only 1 per cent was carried in the cut at first and this grew to only 3 per cent by the crest of the June rise. Following the high water the flow stopped altogether during low water. Again during the 1934 spring rise there was a small flow through the cut which ceased before low water. In October 1934 the cut was opened to low water flow and carried 10 per cent within a day or two after it was cut through which percentage remained unchanged to any great extent during the remainder of the low water season. The April rise in 1935 found an increase to 20 per cent for a 50-ft gage and low water of 1935 built up to 50 per cent for a 6-ft gage. High water in May 1936 showed 33 per cent for a 46-ft gage and 1936 low water showed a gain of 60 per cent for about a 6-ft gage. On the 1937 main flood 37 per cent was carried at a 58-ft gage, but the 50-ft gage showed 42 per cent. Low water in 1937 found 76 per cent at the 6-ft gage and a maximum of 81 per cent at a 4.3 gage height.

RODNEY

Low Water

Date	Natchez Gage Height in Ft.	Per cent of River Flow in Cutoff
7/24/36	4.8	15
	St. Joseph Gage	
8/ 6/37	4.4	50
10/16/37	−3.1	74
	High Water	
3/18/36	31.8	8
5/ 1/36	46.1	
	St. Joseph Gage	
2/25/37	53.7	10
5/24/37	36.0	34

Rodney cut was opened during rising stages in February 1936. The flow reached 8 per cent in a few days and ranged from 8 to 13 per cent throughout the high water period. During the 1936 low water about 15 per cent was carried at a 5-ft gage although measurements as low as 12 per cent and as high as 18 per cent were obtained. At the crest of the 1937 flood 10 per cent of the flow was in the cutoff but this flood enlarged the channel to such an extent that 34 per cent was carried at 36-ft gage in May and the low water channel 50 per cent for a 4-ft gage and a maximum of 74 per cent for a −3.1 gage.

YUCATAN

Low Water

Date	Vicksburg Gage Height in Ft.	Per cent of River Flow in Cutoff
12/22/32	15.7	75
2/ 5/37	7.4	94
	High Water	
5/13/31	25.4	32
1/13/32	38.6	41
4/11/32	37.5	59
4/27/33	48.0	85
4/10/34	34.0	91
5/ 1/36	42.5	85
2/22/37	55.8	60
3/11/37	47.6	89

Yucatan opened by the caving of the Mississippi into the channel of Big Black River in the fall of 1929. The first discharge measurements were made in May 1931 and showed 32 per cent in the cutoff for a 25.4 gage. During a January rise in 1932 a 41 per cent flow was measured at a little under a 40-ft gage. In April of the same year this increased to 50 per cent for a 37.5 gage. December 1932 showed 75 per cent for a 15-ft gage and April 1933 increased to 85 per cent for a 48-ft gage. February 1934 gave 94 per cent for a 7-ft gage and the April rise the same year showed 91 per cent at 34 ft. May 1936 held about the same with 85 per cent for a 42.5 gage. Beginning in 1935 and continuing since that date all low water has been in the cutoff. The 1937 measurements show this same condition exists for all flow below 30 ft on the gage. During the crest of the 1937 flood 60 per cent of the flow followed the new channel and increased to 85 per cent for about the 48-ft gage.

MISSISSIPPI RIVER CUT-OFFS

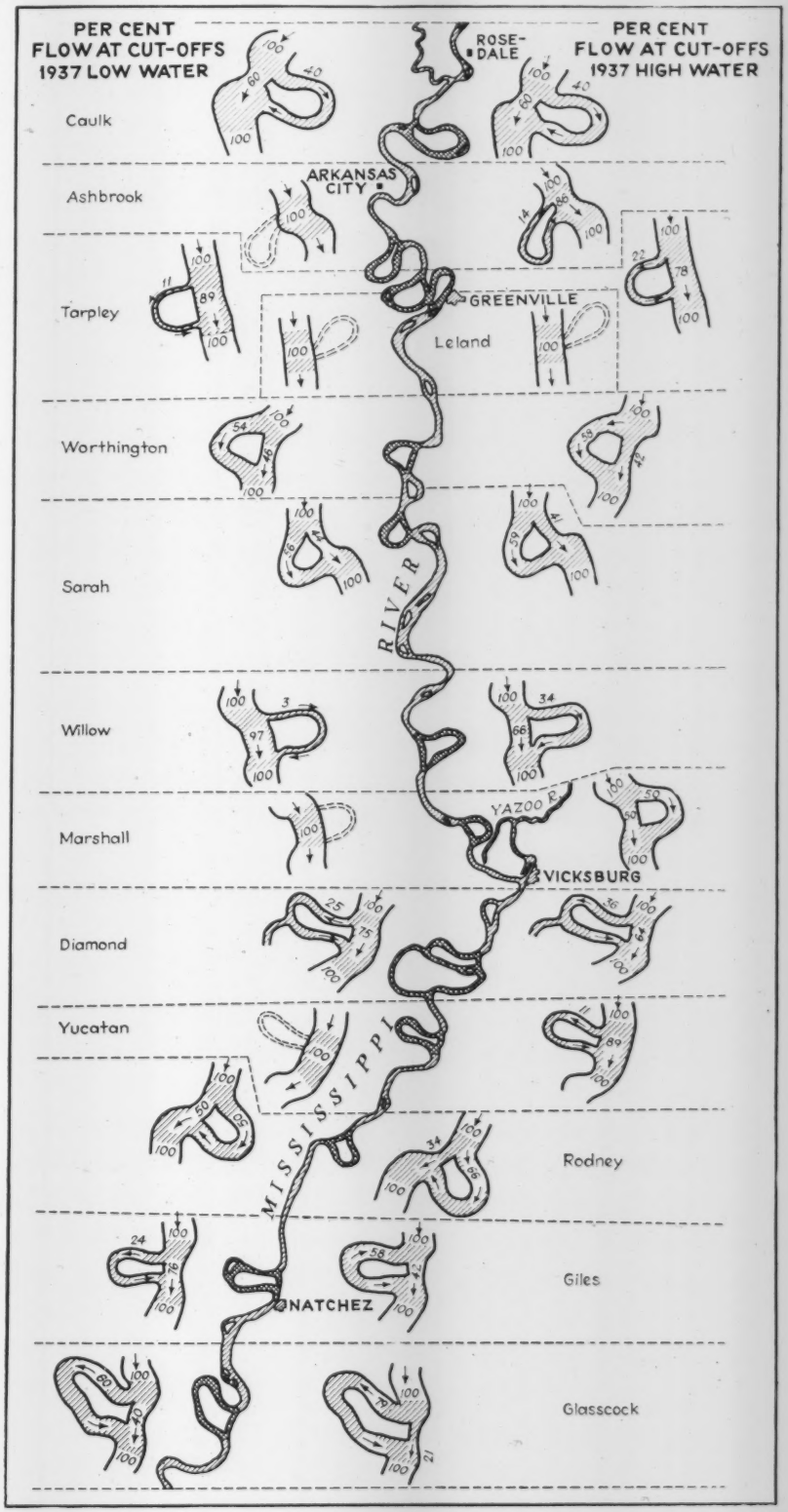


Fig. 14. Distribution of river flow at cutoffs at 1937 high and low water periods. The percentage of flow of the river passing through each cutoff is shown in the enlarged river sections, 1937 low flow at the left and the flow during the 1937 high flow at the right.

DIAMOND

Low Water

Date	Vicksburg Gage Height in Ft.	Per cent of River Flow in Cutoff
11/ 6/33	4.7	36
8/25/34	4.6	42
11/ 8/35	5.0	47
7/ 9/36	4.9	62
11/ 1/37	5.6	75
12/20/37	−2.1	81
	High Water	
1/19/33	38.3	11
4/28/33	48.0	24
6/12/33	48.7	32
4/16/34	34.4	40
4/12/35	48.2	43
7/ 5/35	46.0	54
5/ 5/36	42.0	64
2/22/37	55.5	45
3/11/37	47.6	64

Diamond Cut was opened on the January rise of 1933. By the 19th of the month it had gradually increased to 11 per cent for a little under a 40-ft gage. On the April rise the same year it reached 24 per cent for a 48-ft gage and the June rise went to 32 per cent for about the same gage. Low water in 1933 held 36 per cent for about a 5-ft gage. From 1934 to 1936 slow but progressive improvements were shown, but the low water of 1937 showed a definite improvement with 75 per cent for a 5-ft gage in November and a maximum of 81 per cent for a −2.1 gage late in December.

MARSHALL

Low Water

Date	Vicksburg Gage Height in Ft.	Per cent of River Flow in Cutoff
6/16/34	5.0	7
11/ 5/35	5.1	60
6/29/36	5.3	73
8/10/37	6.2	100
	High Water	
4/17/34	33.6	10
4/16/35	48.2	22
4/28/36	43.7	45
2/17/37	55.1	47
3/15/37	45.1	50

Marshall Cut was opened during the spring rise in March 1934. Flow built up gradually to 10 per cent by the crest of the rise the middle of April. This dropped back to 7 per cent for a 5-ft gage in June and ranged from 6 to 9 per cent during the low water season. The 1935 spring rise showed an increase to 22 per cent for a 48-ft gage and 1935 low water even a greater increase to 60 per cent for the 5-ft gage. The 1936 rise gave 45 per cent for a 44-ft gage and the 1936 low water continued to increase to 73 per cent for the 5-ft gage. During the 1937 flood 47 per cent was carried at a 55-ft gage and 50 per cent at a 45-ft gage in March following the main rise. Low water in 1937 found 100 per cent of the flow in the cutoff for a 6-ft gage in August.

WILLOW

Low Water

Date	Vicksburg Gage Height in Ft.	Per cent of River Flow in Cutoff
6/16/84	5.0	2
11/ 6/35	5.2	52
11/ 5/36	5.6	74
10/ 9/37	−0.9	99
11/22/37	4.4	97
	High Water	
4/10/34	33.9	8
4/16/35	48.2	27
5/ 2/36	43.9	42
2/24/37	55.2	56
3/14/37	43.8	66

Willow Cut was opened during the April rise in 1934. Within two days the flow reached 8 per cent of the total river but fell back to 2 per cent for a 5-ft gage in June and ranged from this to 8 per cent during the balance of the 1934 low water season. During the April rise in 1935 the flow reached 27 per cent for a 48-ft gage. The 5-ft gage during the 1935 low water showed 52 per cent. During the spring rise of 1936 the 44 gage reached 42 per cent and low water showed a continued increase to 74 per cent for the 5-ft gage. At the crest of the 1937 flood 56 per cent of the flow was in the cutoff and in March 66 per cent corresponded to a 44-ft gage. For the 5-ft gage during 1937 low water the percentage reached 97 with a peak at 99 per cent for a −0.9 reading in October.

SARAH

Low Water

Date	Lake Providence Gage Height in Ft.	Per cent of River Flow in Cutoff
6/10/36	6.2	1
8/ 3/37	6.4	44
12/11/37	−0.5	59
	High Water	
4/28/36	37.89	12
2/11/37	46.89	25
5/19/37	31.2	41

Sarah Cut was opened during the rising river in March 1936. About 3 per cent was carried the first day. The flow increased gradually to 12 per cent by the crest of the rise the latter part of April. However this fell back to 1 per cent for a 6-ft gage in June and shut off altogether at low water from July to October. The crest of the 1937 flood showed 25 per cent in the cutoff but a 30-ft stage in May showed 41 per cent which increased to 44 per cent for the 6-ft gage at low water in August 1937 and reached a maximum of 59 per cent for a −0.5 foot gage in December 1937.

WORTHINGTON CUT

Low Water

Date	Greenville Gage Height in Ft.	Per cent of River Flow in Cutoff
6/28/34	6.7	3
9/ 7/35	7.6	9
6/10/36	7.3	19
8/ 4/37	7.7	46
10/11/37	−0.3	48
	High Water	
4/10/34	32.5	3
4/ 5/35	45.4	17
4/28/36	40.9	29
2/ 2/37	46.8	31
2/10/37	51.5	37
3/ 4/37	45.3	42

Worthington Cut was opened during the rising river on Christmas day 1933. The discharge built up slowly as the pilot channel was only a shallow dragline cut. During the April 1934 crest it reached only 3 per cent. Flow dropped back to very small amounts in May and was only 3 per cent for a 7-ft gage in June 1934. The 1935 spring rise showed an increase to 17 per cent for a 45-ft gage but low water dropped back to 9 per cent for the 7-ft gage and fell as low as 4 per cent for an 0.8-ft gage. The 1936 spring rise showed 29 per cent for a 41-ft gage but low water again fell back to 19 per cent for the 7-ft gage and down to 10 per cent for a −3.4-ft reading. The rising stage of the 1937 flood found 31 per cent for about a 45-ft gage; the crest, 37 per cent, and the falling branch of the rise 42 per cent, for about the same 45-ft gage—a marked improvement on this flood.

LELAND CUT

Low Water

Date	Greenville Gage Height in Ft.	Per cent of River Flow in Cutoff
7/31/33	8.8	24
9/18/33	7.9	39
11/27/34	7.8	64
9/ 6/35	8.2	99
9/30/35	3.7	100
*6/ 3/36	8.7	100

* No flow in bend since June 3, 1936 for any stage

	High Water	
4/ 9/34	32.0	42
4/ 4/35	45.4	50
6/28/35	43.4	70
4/30/36	40.7	83

Leland Cut opened in July following the 1933 high water. The flow rapidly increased to 24 per cent of the total river by the end of July for an 8-ft gage and to 39 per cent for about the same gage by the middle of September. The 1934 spring rise reached 42 per cent for a 32-ft gage. Low water of 1934 further increased to 64 per cent for an 9-ft gage although it went as high as 78 per cent for a 0.6 gage. This April 1935 rise only reached [illegible] per cent but the June 1935 rise went to [illegible] per cent for about 45-ft stages. Septem[illegible] 1935 low water reached 99 per cent for [illegible]-ft gage and then went to 100 per cent for a 4-foot gage. The 1936 spring rise [illegible] 83 per cent for the 40-ft stage. [illegible] 1936 the 100 per cent mark was [illegible] crossed and since that date all flow [illegible] bank full has been in the cutoff. [illegible] dike to levee height was built across the old bendway channel.

TARPLEY CUT

Low Water

Date	Greenville Gage Height in Ft.	Per cent of River Flow in Cutoff
12/ 4/35	7.6	66
7/29/36	0.8	100
10/15/36	7.7	89
11/17/37	7.5	89
	High Water	
4/22/35	44.1	5
7/ 2/35	43.3	46
5/ 2/36	39.4	58
2/12/37	52.0	60
3/ 7/37	42.4	78

Tarpley was opened at about the crest of the April 1935 high water and carried only 5 per cent of the flow. On a July rise to almost the same height the same year it had grown to take 46 per cent of the flow. Low water 1935 saw it reach 66 per cent for a 7-ft gage which increased to 89 per cent in 1936 for the same stage. During a short period in 1936 the entire low flow passed through the cutoff. The spring rise of 1936 found 58% in the cutoff for a 40-ft gage which grew to 78 per cent for about the same gage in 1937. At the crest of the 1937 flood 60 per cent was in the cutoff.

ASHBROOK CUT

Low Water

Date	Arkansas City Gage Height in Ft.	Per cent of River Flow in Cutoff
12/ 3/35	8.8	35
6/11/36	8.9	97
7/ 8/36	4.3	100
10/16/36	8.9	88
8/ 5/37	8.7	100
	High Water	
12/27/35	15.5	47
4/21/36	40.3	80
2/18/37	53.4	87
3/ 8/37	41.4	86
11/13/37	12.4	100

Ashbrook Cut was opened in November toward the end of the 1935 low water season. By late December 1935 it had enlarged rapidly to carry 47 per cent at the crest of a small rise. During the spring rise of 1936 this was increased to 80 per cent for a 40-ft gage. Low water of 1936 saw the previous year's 35 per cent increased to 97 per cent for a 9-ft gage and reached the 100 per cent mark for a 4-ft gage. This dropped back to 88 per cent for the 9-ft gage by the end of the low water season but 1937 low water found all the flow in the cutoff below about a 15-ft gage height at Arkansas City. During the crest of 1937 flood about 87 per cent of the flow was in the cutoff channel and 86 per cent at bank full stage.

CAULKS CUT

Low Water

Date	Arkansas City Gage Height in Ft.	Per cent of River Flow in Cutoff
8/ 3/37	9.7	27
11/10/37	10.0	60
12/18/37	0.1	82
	High Water	
5/20/37	36.5	1
12/31/37	19.2	56

Opened May 13, 1937, Caulks Cut carried but 1 per cent of the flow at the crest of the May rise. By August it had grown to take 27 per cent at a 10-ft stage which increased to 60 per cent by November. The greatest percentage at low water was reached in mid December and the highest for medium stages on the last day of the year at 56 per cent and is still growing greater.

Unusual Concrete Rigid Frame Test

Prior to demolition of a 43-ft. span bridge at Glendale, Calif., deflections and steel stresses were measured under loads up to 430 tons

THE NEED for increased channel capacity in connection with a new county flood control project made it necessary to demolish and replace the Central Ave. Bridge at Glendale, Calif., a well-designed reinforced concrete skew rigid-frame structure put in service only two years before. The bridge had a span of 43 ft. between abutments and a total width of 60 ft., which included a 6-lane roadway designed for *H*-20 loading, 5-ft. sidewalks on each side and heavy concrete railings. By reason of the impending demolition it was possible for the city engineer to enlist the cooperation of a number of individuals and organizations in making a load test in which there were no restrictions dictated by risk of damage to the structure. The test consisted in applying a concentrated load at the center of the span and measuring stresses and deflections at various points as described below.

Test procedure

Steel stresses were measured directly over the haunches, beneath the crown, and at several other points in the deck as indicated by letters in Fig. 2. The stress variations in the longitudinal steel as the load changed were obtained by chipping away the concrete to expose the steel and applying 10-in. Whittemore strain gages. For the transverse steel, where there was not room for the 10-in. gage length, a 2-in. Berry strain gage was used.

Deflections of the crown were measured by dial gages beneath the center and near the outer edges on the center line of the span. Each of these gages was mounted on an independent timber tower built up from the bed of the stream. Lateral deflections of the bottoms of the abutments were measured by dial gages located near each corner on the stream side of the abutments.

An attempt was also made to measure the warping effect by means of dial gages located above each corner of the deck, and bearing on a bolt set in the concrete. Each group consisted of three gages, one reading the vertical component of the movement, the second the movement parallel to

Fig. 1. Concrete bridge of 43-ft. span subjected to a transverse centerline load of 430 tons of ingots. Timber towers are for mounting deflection gages.

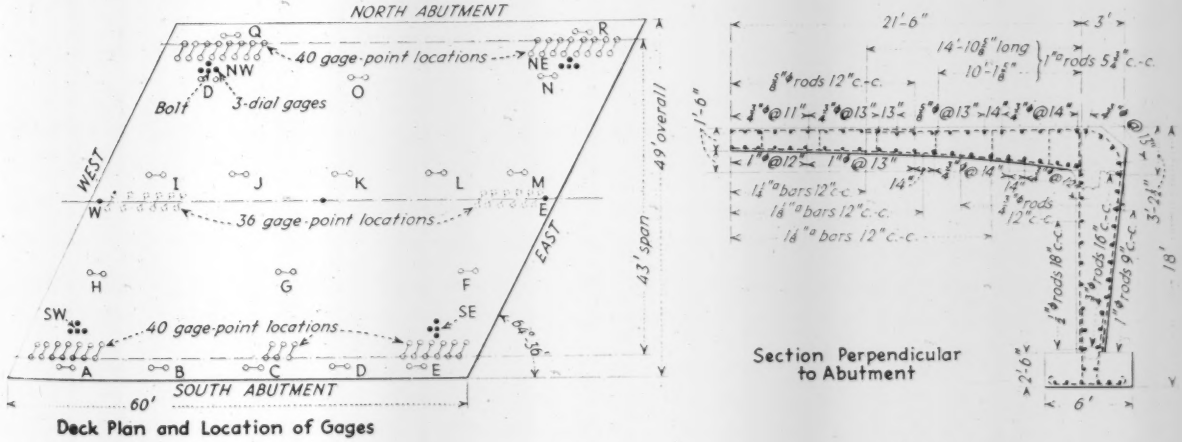


Fig. 2. (Left) Plan showing locations of gage points. (Right) Showing reinforcing steel section.

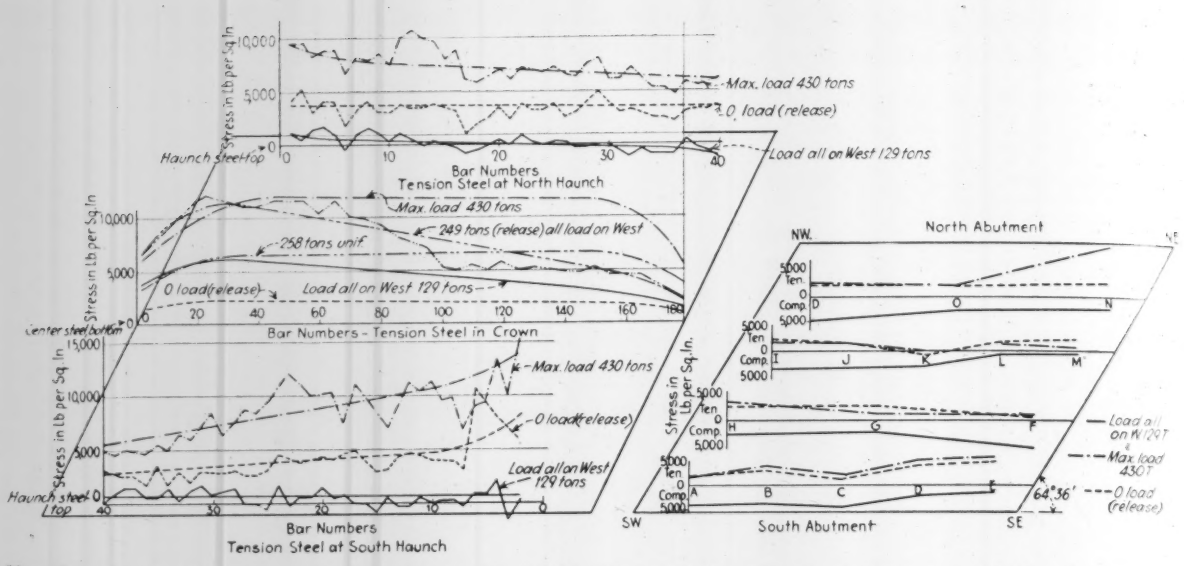


Fig. 3. Stresses measured in the reinforcing steel. Left, tension steel at span center and abutments. Right, transverse steel at gage point locations indicated by letters on Fig. 2.

the face of the abutment, and the third the movement at right angles to the face of the abutment. These gages were attached to 12 x 12-in. timbers cantilevered from the fill back of the abutments.

The load consisted of 3,000-lb. steel ingots which were brought onto the bridge by trucks, swung into position by a crane and gently placed on timbers parallel to and on each side of the center line, thus spreading the load over a transverse strip about three feet wide at the center of span.

Load was first applied to the west half of the bridge only, until a total of 129 tons had been placed. Deflections were recorded at frequent intervals during the 3 hr. required to place this load. Strain gage readings were then taken on 40 bars over each haunch and on 36 bars beneath the crown, as well as on 18 other top bars located at the various points indicated in Fig. 3. Load was held at 129 tons for approximately 3 hr. after which the gages were again read before resuming the loading. During the following 2 hr. and 40 min. an additional 129 tons was placed on the east half of the bridge, resulting in a uniform load along the center line of 258 tons.

Strain gage readings were again taken, and no more load was applied until the following morning, a total of 15 hr., 30 min. Strain readings then were taken again and loading was resumed. During the next 3 hr. load was applied on the west half at a fairly uniform rate until a total of 360 tons was on the bridge; 231 tons on the west half and 129 tons on the east half. Strain gage readings were taken at this stage and after an interval of about 1 hr., loading was resumed until the total load, almost uniformly distributed over the center line, amounted to 430 tons. This load was left on the bridge for 11 hr., 30 min. Strain gage readings were taken at the beginning and end of this period.

In removing the load the east half was entirely cleared before starting to remove the ingots on the west half. Readings of stress and deflections were taken under this unbalanced load of 250 tons. Complete unloading required about 14 hr. Gage readings were taken immediately after unloading and 12 hr. later.

Material quality checked

To check the initial stress in the haunch steel and the quality of the material, several bars were cut out with a torch, and tested in the laboratory. These tests indicated structural grade steel with a yield point of 44,800 lb. per sq. in., an ultimate strength of 69,100 lb. per sq. in., and an elongation in 8 in. of 24 per cent.

A number of 4 x 8-in. cores cut from the concrete gave ultimate strengths varying from 4,060 lb. per sq. in. to 6,210 lb. per sq. in. One sample was carefully loaded to obtain the stress-strain curve. This cylinder broke at 7,820 lb. per sq. in., and the secant modulus of elasticity at 2,000 lb. per sq. in. was 3,640,000 lb. per sq. in.

Results of tests

The stresses and deformation under the various loads are indicated in the accompanying figures.

Fig. 2 is a plan view of the bridge showing the location of test bars and dial gages. The symbols made with full lines indicate locations of gage points in the steel in the upper surface of the deck. Symbols made dotted indicate the location of gage points in the steel of the crown on the lower surface of the deck. The filled-in circles show the location of gages for measuring deflections of the structure. Those near the four corners are on the upper surface of the deck and were used to measure horizontal and vertical movements at the indicated points. Those along the east and west center line are located beneath the crown and were used to measure vertical deformations.

Fig. 3 (Left) shows steel stresses at the center of the span and in the north and south haunch steel, for various loadings. The irregular lines represent recorded stresses. A smooth curve also has been drawn in each case to indicate the probable actual variation in stress across the bridge. In some cases the resulting smooth curve alone has been shown in order not to confuse the figure by drawing the lines of recorded stress. The reduction in stress of the crown steel at the outer edges of the bridge, com-

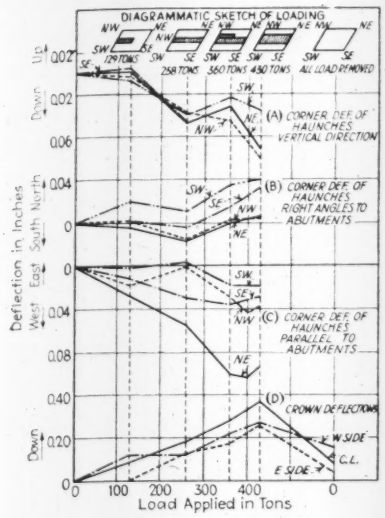


Fig. 4. Deflections measured by dial gages at corners and at center of span.

pared with that at the center of the bridge when the bridge is fully loaded, indicates the effect of the concrete railings and sidewalks upon the rigidity of the structure.

Fig. 3 (right) represents variation in transverse steel stress for three different loadings of the bridge. Note that the zero lines of stress in each case are shown at the position on the bridge where the steel stress measurements were made.

The curves in Fig. 4, shown above, were determined from the readings of the dial gages at the four corners of the deck and indicate the movements of these points (1) in a vertical direction, (2) in a direction at right angles to the abutments, and (3) in a direction parallel to the abutments. The accuracy of some of the points on these curves is reported as questionable because of interference with the gage supports. However, it is believed that in general the movements indicated are those which actually occurred.

Fig. 4*D* represents the deflections of the crown and was obtained from readings of the gages located beneath the structure.

Lateral deflections of the abutments measured at points 8 ft. below the juncture of the slab and the abutment indicated that there was an apparent movement inward during the test with very little spring back when the load was released. The magnitude of the movement at maximum load varied from a minimum of 0.008 in. at the southwest corner to 0.014 in. at the northwest corner. The correctness of the dial readings was checked by several men. No explanation of the unexpected direction of movement is offered except the fact that the original concrete channel slab had been broken out and the earth in the center of the channel excavated to a depth slightly below the footings. This release of resistance to pressures from the approach fill, it is thought, might have permitted the movements noted.

The influence line values at the center section for load at the center are as follows: Bending moment $M_Z = 3.99$; torsional moment $M_V = 1.70$; normal thrust $T_V = 0.43$; tangential thrust $T_Z = 0.17$.

The structure was designed for an *H*-20 loading on each of the six lanes, following very closely the method of analysis first proposed by A. G. Hayden of the Westchester (N. Y.) County Park Commission. Concrete stresses were based on an assumed strength at 28 days of 2,000 lb. per sq. in., and the steel was assumed as structural grade. No consideration was given to the effect of the approach fills against abutments.

The bridge was designed in Glendale by J. C. Albers, city engineer, and his two assistants, C. D. Ament and W. L. Dickey, with Prof. R. R. Martel, California Institute of Technology, Pasadena, as consultant. Construction was carried out with unusual care and close supervision.

The tests were made possible by the initiative of Mr. Albers, and were planned and carried out under the general supervision of C. D. Wailes, district structural engineer, Portland Cement Association; Walter L. Dickey, Glendale engineering department; L. T. Evans, U. S. Engineer Department field staff; and Prof. Frederick J. Converse, California Institute of Technology.

Steel ingots were loaned by H. L. Christie, Columbia Steel Co. Frank Howard, Howard Engineering Co., cut the six 4 x 8-in. concrete cores with a Concore machine. P. C. Hanger, Los Angeles city bureau of standards, provided equipment, and aided by reading instruments and testing the steel. The Smith Emery Testing Laboratories loaned instruments and tested concrete. The California Institute of Technology loaned instruments and assisted in the calculation of data.

Street Paving Price List and Catalog

TAXPAYER GROUPS in Altoona, Pa. who are planning a petition for the installation of street paving, are assisted in making a selection of the type of improvement by consulting a "catalog" prepared by the city engineering department. The catalog is simply a blueprint on which is shown the three recommended types of pavement and the approximate cost per linear front foot. From this the citizens preparing the petition may inform themselves regarding materials to be used, kind of curb and gutter construction, and the estimated cost of various widths of paving.

Three alternate types of paving can be selected, namely, type A—reinforced concrete with integral curb; type B—broken stone base and 2-in. bituminous top with integral curb; and type C—cement-bound macadam with standard concrete curb. The latter is the cheapest, costing $3.90 per lin.ft. for a 24-ft. width; types A and B cost $5.66 and $4.36, respectively.

The availability of a reference chart such as this not only provides the petitioners with conveniently arranged comparative information but, in addition, saves the engineering department from the task of making numerous preliminary estimates. The charts were made under the direction of H. J. Baum, city engineer.

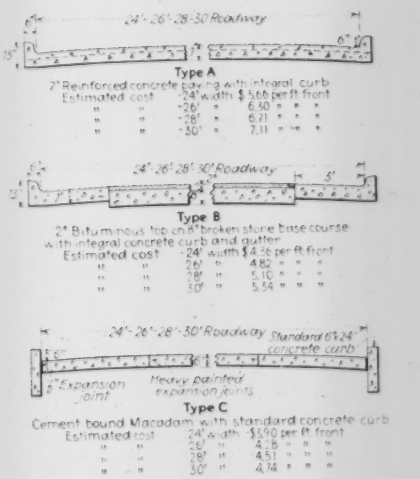


Fig. 1. Street paving types and costs "catalog" prepared for the convenience of taxpayer groups.

Lift Bridge Mechanisms and Controls

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Torrence Ave. lift bridge in Chicago typifies modern installations in general but in addition includes many new mechanical and electrical devices and is operated by its own power plant

WHEN, having standardized for nearly 40 years on bascule bridges, the city of Chicago determined on a vertical lift as the best type for a bridge over the Calumet River at Torrence Ave., it was apparent that a complete redesign of customary motive equipment was necessary. The lack of similarity between the vertical-lift bridge and the bascule led to an unusually thorough study of suitable mechanical and electrical equipment, with consequent engineering development in these items. To add to the problem, the bridge is located in the southeastern part of the city at a considerable distance from customary power facilities. In consequence the design was for a bridge with its own power plant.

The lift span of the Torrence Ave. bridge is a 276-ft. skewed Warren truss with subdivided panels. It is suspended at each corner from twenty 2¼-in. wire ropes, passing over 15-ft. diam. sheaves and attached to steel box counterweights. A 44-ft. roadway and two 8-ft. cantilevered sidewalks are provided. The towers, parallelograms in plan, are 34½ ft. from front to rear to correspond with the panel widths of the trusses. Each tower column is supported by a cylinder pier extending 80 to 90 ft. to rock.

Hoist type selection

Comparative studies, made of several types of span hoist, led to the adoption of a counterweight-sheave drive in which the cables pass up over driving sheaves to balancing counterweights traveling up or down within the two towers, on top of which all driving machinery is located. For obvious structural and architectural reasons this type of design was preferable to a cable-operated design with the machinery supported on the span at the center. A further consideration was safety to roadway traffic. Experience on other Chicago bridges bears out the need of stationing operators at the ends of the bridge where traffic can be observed at all times. On a cable-operated span three attendants, therefore, would be required, whereas one operator in the main tower and a gateman at the opposite end are sufficient for the sheave-drive type.

The sheave-drive type, having independent machinery located in each tower, requires some means to insure that each end of the span will travel at the same rate. A synchro-tie drive is used for this purpose, consisting of 3-phase wound-rotor induction motors in each tower, directly coupled to the same gear-train shaft as the span-driving motors. The rotor circuits of the induction "tie" motors are electrically connected through cables, while their stator circuits are excited from the same power source. When a phase relationship is established between the two tie motors any movement of the rotor of one tie motor will cause a like movement in the other tie motor, varying only by a few electrical degrees, dependent on the resisting torque. Hence any tendency of one tower's drive motor to run ahead will be transmitted through the synchro-tie motors to the far tower and cause a like speed for that end.

To provide the maximum degree of operability, the two tie motors are identical in size and construction with the drive motors. Being identical, the functions of the tie and drive motors can be interchanged, thus permitting operation in case of failure of one tie motor. While it has been proposed for synchro-tie bridge drives that the tie motors might be a fraction of the horsepower of the drive motors, experience on the Torrence Ave. bridge does not verify this; watt-meter readings of power transferred by the tie motors during operation of the span while under construction were at times as great as those shown for the drive motors alone.

The two motors on each tower are coupled to the opposite ends of a high speed shaft of an open gear train located centrally at the tower top as shown in Fig. 2. Cross shafts extend from each side of the gear train to a bevel gear reduction at the outer ends, the bevel gears being necessary because of the skew of the towers. The bevel gears are held in alignment by a unit bearing frame and are totally inclosed. The large bevel-gear shaft carries the main drive-pinion meshing with a circular rack bolted to the side of the counterweight sheave.

The intermediate high speed shaft of the gear train carries a differential provided with a clutch. The differential is so arranged that, with the clutch engaged, the differential gearing revolves as a unit, driving both cross shafts equally; with the clutch released, the differential drives the side with least resistance. Release of the clutches, which are spring set, is effected by 8-in. stroke, 800-lb. thrustor, operating through a suitable linkage. The purpose of this feature is to permit lateral seating of the corners of the bridge, as may be necessary should creep or stretch of the ropes occur on the counterweight sheaves, thereby allowing one corner to seat before the other. It is

Fig. 1. Chicago lift bridge, built on a skew, is raised by 80 wire ropes operating over 15 ft. dia. sheaves

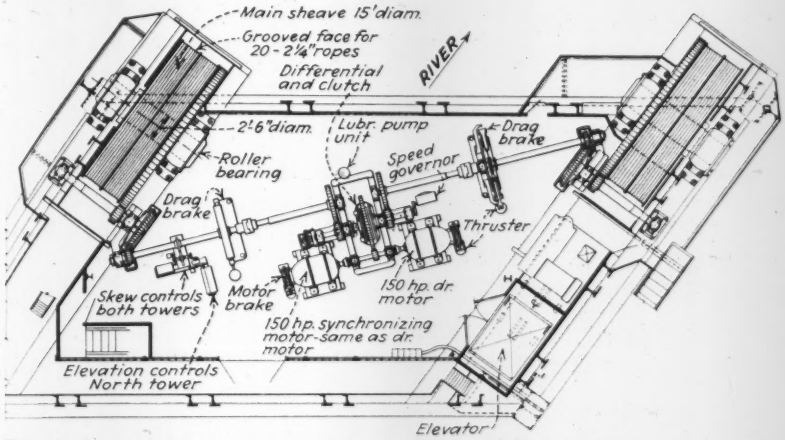

Fig. 2. In machinery rooms at the tower tops are located the drive and synchro-tie motors operating the counterweight sheaves through bevel gears on cross shafts

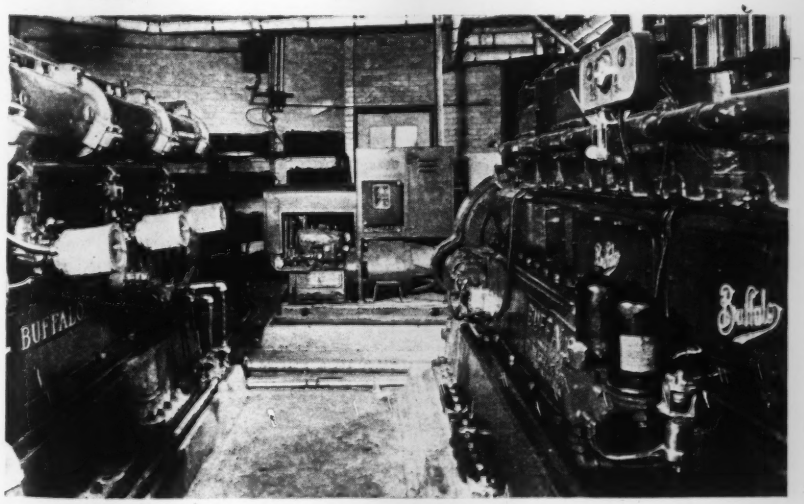

Fig. 3. Two 550-hp. gasoline engines, largest of type yet built, direct connected to 300-kw. generators constitute the power plant

especially important on a wide highway bridge, such as this, that all corners be fully seated to insure matching of the fixed and movable roadway and sidewalks. This seating feature was found particularly valuable for leveling and alignment purposes during construction.

Sheaves

Economy of design of both the lifting girders and the driving machinery, resulting in lessened material and erection costs, was obtained by grouping the counterweight ropes as near the truss connections as possible. This makes necessary a wide sheave face with consequent larger shafts but results in fewer bearings and a simplified drive. The method of shrinking these shafts with dry ice to insert them in the sheaves, as well as the erection of the sheaves, was described in *ENR* May 27, 1937, p. 774.

The sheave shafts rotate in roller bearings, which are the largest ever constructed for this purpose, each bearing carrying a load of 816,000 lb. They are of the fully-hardened straight-roller type, with a bore of 30 in. and an external diameter of the outer race of 47 in. This outer race is carried in a spherical seat to permit of self-alignment under deflection of shaft or carrying girders. A nominal sized roller thrust bearing is also used in each assembly to provide for any lateral load transmitted to the sheaves. The use of roller bearings reduced the required motor horsepower by more than one-half, with attendant reduction in the gearing and shafts and also in the size of electrical equipment and power source, all of which more than offset the increased cost over plain bearings.

Brakes

The braking equipment for the bridge consists of two pair of motor brakes and two pair of drag brakes. These latter brakes are mounted on the cross drive-shafts and consist of 5-ft. cast-steel wheels gripped by floating jaws which are spring set. Release is accomplished by 6-in. stroke, 600-lb. thrustors operated by a variable-speed motor. While their main function is to provide adjustable retarding force when lowering the span with heavy ice loads, these

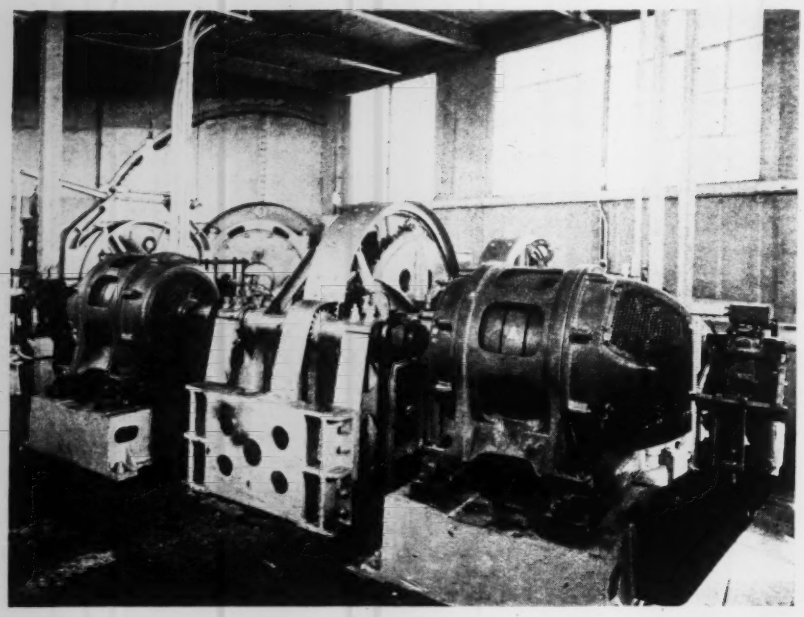

Fig. 4. Machinery on the tower top. The tie motor at the left is electrically connected to a similar motor on the opposite tower assuring that the drive motor at the right will keep in step with the drive motor on the opposite tower

brakes may be adjusted to hold the span in the up-position under an unbalanced condition of 15 lb. per sq.ft. of deck area, or 274,000 lb. The location of these brakes on the cross drive-shafts permits the removal for repair of any portion of the main gear train or the operating motors with the span raised.

Besides the drag brakes, each of the four span motors is provided with a thrustor-released brake. These brakes are arranged to be applied in pairs in two successive steps at the will of the operator. To prevent excessive strains on the machinery in emergency stops, time delays are provided for the stepped application of all brakes.

The use of an independent power plant necessitated special features to provide for regenerative action of the motors. Whenever extreme ice loads are encountered the span may overhaul the motors during lowering, which will reverse the performance of the motors and generators. Under this overhauling condition the motors generate power, functioning as asynchronous generators, and their output is absorbed by the engine-driven generators. The braking effort exerted by the engines is limited and the regenerated power tends to overspeed the generators. This possibility has been forestalled by the use of a regenerative power-absorbing resistor, this being undoubtedly the original application of such a device. This resistor is connected to the generator bus through the medium of a speed governor when the motors reach 105 per cent of synchronous speed. The effect is to permit the engine-driven machines to continue to function as generators while speed, voltage and frequency remain near normal.

Unbalanced loading

For normal operation the gearing was designed to lift the span 104 ft. in 100 sec. of continuous travel with an unbalanced loading (from snow and ice) equal to 2½ lb. per sq.ft. of span roadway and sidewalk area, plus the additional friction of span rollers and counterweight guides due to a lateral wind force of 2½ lb. per sq.ft. on 1½ times the vertical projection of the span and counterweights. This loading required the selection of a motor size that would operate at slightly less than full-load capacity for this condition so that in case of failure of one drive motor the remaining motor's overload capacity would be sufficient to lift the span through the tie motors. The gearing is also designed to have sufficient strength to lift the span under a maximum unbalance of 5 lb. per sq.ft. of span area but at a somewhat reduced speed. In addition to these two specific span loadings the section of gearing extending from the drag brakes outward to the sheaves is designed to carry the stresses due to holding the span with 15 lb. per sq. ft. unbalance.

Final balancing of the span and counterweights was accomplished by observing wattmeter readings for travel in each direction, and shifting counterweight blocks until 5 kw. more power was required for hoisting than for lowering, thus insuring a slightly heavier span for positive seating conditions.

Power plant

Perhaps the most unusual feature of this bridge is its own power plant, located at the north end of the bridge. Investigation indicated that first cost, available room and quick starting ability with unattended operation all favored a gasoline-engine-driven generator set. The main power units selected for operating the span and auxiliary equipment are two 8-cylinder, 550-hp., 1,200-rpm gasoline engines, each direct-connected to a 300-kw., 60-cycle, 480-volt generator and exciter. These units are the largest built in this type. During the acceptance tests a maximum generator output of 357-kw. was developed, a satisfactory margin over the 300-kw. required by the specifications. Either unit has sufficient capacity to operate the bridge, and has demonstrated its ability to lift the span with greater loads than will probably ever be experienced from snow and ice. Power is carried from the north side plant to the south tower through an existing pipe tunnel under the river.

A single smaller gasoline-electric generating unit of 11-kva. capacity is used as a standby for the 110–220-volt single-phase lighting supply line. This set is of the fully automatic type, arranged to start and come on the line upon the failure of the single-phase utility supply.

Controls

The starting and stopping of the units is controlled electrically from the operator's room, located four stories above the engine room. Indicator lights and warning signals show the functioning of the oil, water and gasoline. The span controls are so lo-

cated that the operator is required to move to a point of vision, whether it be for road or river traffic. Thus the traffic signals, gates and barriers are controlled from a switch box mounted at a window mullion on the landward end of the house, while the span-operating controllers are at the river end. Span indicators are located at eye-height, requiring no glancing down for observation. Switches, which ordinarily will not be operated with the span in motion, such as engine-starting switches, end-lock switch, high-cutout switch and reversing switch, all having convenient pistol grip handles, are located on a central desk. Also on the desk is the skew limit bypass button and the various sealed interlock release toggle switches. At the back of the desk on a sloping panel is located a voltmeter, ammeter for each drive motor, ammeter for auxiliaries and a differential watt-meter showing tie transfer power. Indicating lamps on the desk show engine operation, while bells within the desk warn of high cooling-water temperature and also of wrong controller-set-up. Within the desk is mounted the automatic rheostatic-leveling controller which comes into use in case of failure of the tie motors.

An innovation in bridge indicating equipment is a panel directly in front of the operator on which is laid out diagrammatically the various parts of the machinery at the tower tops. Indicating lights at the item they represent illuminate an appropriately-lettered colored lens whenever the particular piece of equipment is functioning correctly. Thus the operator can tell at a glance which brakes are released, which motors operating, which corners are seated, etc. Immediately to the right of this, at a convenient angle of vision, is located the level indicator dial showing in inches whether either end of the span is high or low. Below, in the same case, is mounted the height indicator, reading in feet above down position and having a vernier pointer reading in inches for the end points of travel.

The arrangement of controllers is somewhat suggestive of street car practice. The span controller is on the operator's left and controls only the directional and accelerating contactors while, contrary to usual practice on similar bridges, the control of brakes and tie motors is located in a separate controller at the operator's right. This separation of brake control from the span motor is advantageous in permitting individual adjustment of braking effort, resulting in smooth seating and better handling under ice loads.

Rheostat levelers

The rheostatic leveling device, which is to be used in case of failure of the synchro-tie system, consists of a differentially-wound selsyn motor driving cams that are arranged to open or close five steps of motor resistance in conjunction with the span controller. The selsyn motor is electrically connected to selsyn generators driven from the machinery in each tower top. As long as both tower drives rotate at the same speed, the differential selsyn is stationary. Advance of one span end relative to the other will cause the differential selsyn cams to open resistance contactors on that end thus slowing it down. The skewed-end condition of this bridge necessitated close limits of leveling control as binding will occur at about 17 in. out of level. All five steps of leveling control come in within 9 in. out of level. Tests have shown that this leveling controller keeps the span within 2 or 3 in. of level. A hand-leveling controller parallels these same circuits and permits manual leveling in case of selsyn failure.

An additional span-leveling device, an ultimate skew limit switch, is also used. It was developed by Westinghouse for an earlier bridge of this type and has been used on all similar bridges since. Other protective features include the usual overload and undervoltage devices, slow-down and stop at travel limits, overspeed, and the previously described overhauling protection.

A limit switch driven from the north tower gearing stops the span a few feet short of each extreme of travel, requiring the operator to center his controls and restart. It also stops the span at its ultimate upper travel. Interlocking circuits are also controlled through this and other limit switches on the balance of the equipment. The interlocking system is such that the correct sequence must be followed for all operations during a routine lift.

Consistent with regard for safety of roadway traffic, a yielding barrier is placed at each tower across the roadway in addition to the conventional roadway gates. It consists of a net of wire rope arranged to be lowered across the roadway whenever the span is to be raised. Electrical interlocking prevents span operation until all traffic devices are in the closed position. The barriers are designed to yield on impact yet provide sufficient resistance to stop a 4,500-lb. vehicle traveling at 45 mph. in a distance of 18 ft. An electrical drive beneath the roadways performs the raising and lowering operation.

Fig. 5. In the control house the operator is required to move to the window to operate the controls

Miscellaneous equipment

At each end of the bridge, locks are provided to hold the span on its seats. The driving mechanism for each lock is mounted on the tower masonry beneath the roadway and consists of a speed reducer coupled to a crank actuating a connecting rod and lock bolt that engages a socket on the end floorbeam. A 5-hp. line-start induction motor furnishes power, and is supplemented with provision for hand operation.

To cushion the seating of the span, air buffers are provided at each corner. A similar buffer is installed at each corner on the towers for the upper limit of span travel.

The bridge, being gasoline-operated, it was essential that adequate fire protection be provided. To this end a carbon-dioxide gas system is used, having nozzles piped at inter-

vals around the engine room walls and gasoline tank enclosure. Gas is released automatically by heat-actuated valves, or if desired by hand control.

To facilitate rapid access to the tower tops an elevator of 2,500 lb. capacity is installed within the framing of each tower. The elevator is operated from the same 440-volt a.c. as the balance of the equipment.

The total cost of the improvement, including relocation of the old bridge as a temporary crossing, was $1,330,000. It was financed from a grant of $472,500 from the PWA, $740,000 from the city's share of motor fuel funds collected by the state of Illinois and the balance from the city's surplus funds from a previous bridge bond issue.

The bridge was built by the department of public works, Oscar E. Hewitt, commissioner; Loran D. Gayton, city engineer; Thomas G. Philfeldt, engineer of bridges; C. S. Rowe, engineer of bridge construction and the writers. The steel and machinery in general, were fabricated by the American-Bridge Co. and erected by the superstructure contractor, the Great Lakes Dredge & Dock Co. The Westinghouse Electric & Manufacturing Co. supplied the motors and control equipment and co-operated with the city in the details of control design. All electrical work was installed by the Central States Electrical Construction Co. of Chicago.

Railroad Use of Construction Equipment

American Railway Bridge and Building Association discusses increasing use of equipment for construction and maintenance and use of new construction materials

METHODS, materials and machine equipment for railway construction and maintenance were passed in review at the well attended annual meeting of the American Railway Bridge and Building Association, held at Chicago on Oct. 18 to 20. Some of the methods and equipment would apply to work done by contract as well as to that done by railway forces. Pertinent discussion was the strong point of the meeting. Indicative of the railway situation, however, was the fact that for the first time in several years the manufacturers and railway supply houses failed to provide an exhibit of their materials and equipment.

President for 1938-39 is F. H. Masters, assistant chief engineer of the Elgin, Joliet & Eastern R.R. The secretary is C. A. Lichty, of Chicago.

Pile drivers and cranes

Pile driving equipment was made the subject of two reports, one on field methods in the construction of timber trestles and the other on the use of pile driving equipment in modern bridge work. Both pointed to the advantage of high power, self-propelling machines, operated by steam or oil engines. Convertible machines which may be used as grab-bucket excavators, crane or as pile drivers are favored on some roads. A special convertible machine on the Delaware & Hudson has the boiler carried on a separate car, so that there is only a short tail swing for work in restricted spaces or to avoid fouling trains on an adjacent track.

Large cranes are still used for a variety of purposes such as handling materials, rails and bridge girders or structural steel, as well as for excavation and for repair work at washouts. Wrecking cranes of 60 to 200 tons capacity, for use at train and track accidents, are often used for bridge erection and are even loaned to contractors for such work. As much of the steam equipment is said to be obsolete, the report urged the importance of keeping the existing machines in good working order.

For a variety of light work, a small full-revolving self-propelled crane of the type used in rail renewal is a very efficient machine. In a special class of smaller machines are off-track gasoline powered derricks, drag-line excavators, tractors and cranes, many mounted on crawlers. Such machines have advantages for work where rail traffic is heavy, and in some cases have placed the girders of overhead bridges in less time than would have been required to lay temporary track for a locomotive crane. These off-track machines are likely to be used increasingly on bridge and building work, pile driving, ditching, pipe laying and backfilling according to the reports.

Maintenance of movable bridges

Swing, bascule and lift bridges were covered in one report, both as to general substructure and superstructure and the machinery equipment, as well as such details as end rails and end locks. The report noted the importance of operators being thoroughly familiar with the functioning of the various devices involved in the safe and efficient operation of the bridges, and stated that this expert familiarity should be checked occasionally under service conditions.

Operating tests should be made under unfavorable as well as favorable conditions, and tests of brakes, air buffers and other emergency devices should be carried to the point where these devices actually function. Frequent and complete tests are assurance against serious trouble. Auxiliary or stand-by power units need to be operated at intervals, both to insure that they will be ready when needed and to insure that the operators are capable of handling them in case of necessity. Cases of trouble due to neglect of this obvious precaution were cited.

Preframing of timber before preservative treatment, and even for timber that is not to be treated, is in-

creasing steadily. This practice necessitates greater accuracy in field methods, particularly in placing the pile bents. Power-driven tools are used extensively, but to be economical the work must be extensive enough to keep them well employed. On any fair-sized job, the report on trestle construction stated, such power tools as boring machines and saws should more than earn their carrying charges. Pneumatic tools have been in use for years, but more recently there has been extensive use of electric tools, due mainly to the development of light-weight portable, gasoline-powered generators. One road reported that with an electric saw two men can do the work requiring six men for hand sawing, and one man with an electric drill can do as much work as six men with hand drills.

Water pipe lines

For service conditions on railway work, a report on water pipe lines set up the following classifications: (1) Low pressure, as for filling tanks or reservoirs; (2) Normal pressure with occasional high pressure, as when connected to a city supply having increased pressure in case of fire; (3) Those subject to high pressure and to water hammer, as in serving water columns. Besides piping of various metals, mention was made of asbestos-cement pipe as desirable for lines subject to tuberculation or electrolysis. Joint construction, corrosion, outside covering and wrapping and inside lining were all covered in the report. Practice of a large western railroad, taken as generally representative, was given as follows: Wood pipe, 2 to 10-in. diam., on gravity supply lines not exceeding 65 lb. pressure. Steel (black); ⅜-in. to 12-in., on heating systems and temporary supply lines. Steel (galvanized); same sizes, for exterior piping, as at stockyards, and for interior piping. Cast-iron; 3 to 14-in., for underground supply lines at water-treating plants, roundhouses and for fire protecting systems, in corrosive soils or cinders and for pressures up to 100 lb. Small pipe, 1¼-in. to 3-in., for similar purposes and conditions, with pressures up to 100 lb. Wrought iron; ⅜-in. to 12-in. for permanent use on storage tanks, riser pipes and interior piping exposed to corrosive gases. Copper, ⅜-in. to 2½-in. for underground supply lines to stations, stockyards, etc., with pressures up to 60 lb.; also for laying in corrosive soils or cinders. Asbestos-cement pipe has been used satisfactorily, while coated wrought-iron and coated spiral welded steel pipe are being studied for underground installations. Sleeve-type couplings are found more economical than calked pipe joints on pipe of more than 8 in. diameter.

Insulation of buildings

Railways in general are found to be backward in the application of insulation as economical protection against heat and cold, but this is due in part to financial conditions. The Baltimore & Ohio adopted the policy 12 years ago and has applied insulation to about 150 buildings, including 7 passenger stations, 63 water-treating plants, freight houses and office buildings. On the Western region of the Canadian National, 865 buildings have been insulated, including 448 stations, with an estimated saving of 25 to 35 per cent in fuel, so that the cost is retired in three or four years. In new insulated buildings, also, radiation and boiler capacity may be 30 to 40 per cent less than in buildings without insulation.

Miscellaneous subjects at the meeting included the design and maintenance of cinder pits. The old type of pit with depressed track is still in extensive use, but recommendations favor water-filled pits and mechanically-operated skip-hoist pits. A report on the possibilities and limitations of the acetylene cutting torch showed that operators are in some cases trained at classes held at the shops. This training is valuable, as they learn to know metals and their technique in cutting, as well as the use and care of the equipment. In a bridge gang of 10 to 12 men, the number of torch operators varies from one to five. Besides reviewing the more common uses of the cutting torch, the report listed a number of unusual and special uses, such as cutting several thicknesses of plates clamped together and cutting metal under water.

JERSEY APPROACH TO LINCOLN TUNNEL

THE LOOP roadway approach to the Lincoln tunnel on the New Jersey side was opened to traffic Sept. 15. The new loop is conspicuous in the above view, which shows the approach nearing completion.

Starting at the south end of Weehawken Plaza, the 4,000-ft. six-lane viaduct swings east to cross Hudson Boulevard and turning north runs along a rock shelf cut in the western flank of King's Bluff; it then recrosses Hudson Boulevard and proceeds west where it will join the depressed express highway across the Palisades, which will be opened next summer.

BOOK NOTES AND REVIEWS

The month's additions to the engineer's reading and reference list

Water Supply Engineering

ELEMENTS OF WATER SUPPLY ENGINEERING—second edition—By Earle L. Waterman. 329 pp. Published by John Wiley & Sons, Inc., New York, and Chapman & Hall, Ltd., London. Price, $3.50.

This new edition of a book written primarily to serve the needs of students beginning the study of water supply engineering has been revised and considerably expanded. Keeping pace with new developments since 1934 when the first edition was published, new sections have been added giving information on mechanical equipment for water treatment plants, the use of activated carbon for the control of tastes and odors, the Hardy Cross method of analyzing flow in distribution pipe networks, and the Proctor method for the design and construction of rolled-fill earth dams.

Park Structures

PARK AND RECREATION STRUCTURES—3 volumes—prepared by National Park Service, U. S. Department of the Interior. For sale by the Superintendent of Documents, Washington, D. C. Price, 75 cents for each volume (paper covers).

Fast strides forward have been made in the development of natural parks so that they can be put to greatest public use and enjoyment. The installation of structures and facilities to properly care for and administer to the needs of those who visit these parks has been actively promoted during recent years. To place on record some of the work that has been done and to stimulate further improvement in the design requirements in this special field is the purpose of this three-volume publication. It is a compendium of practice in all sections of the country, and brings together representative examples of successful designs of park structures.

Part 1, entitled "Administration and Basic Service Facilities," deals with access, circulation, supervision and maintenance structures, and those services requisite for safe and continued public use of the parks. Recreational and cultural facilities, such as picnic areas and appurtenances, trailside shelters, bath and boat houses, markers, museums and historical preservation are considered in Part 2. The third volume concerns itself with overnight and organized camp facilities, including tent and trailer campsites, cabins, community buildings and organized camps.

Advanced Structures

AIRPLANE STRUCTURES—Vols. I and II. By Alfred S. Niles and Joseph S. Newell. 451 and 177 pp. Published by John Wiley & Sons, New York and Chapman & Hall, London. Price $5 and $2.75, respectively.

Although this book is written for structural designers of airplanes, it should be read by any structural designer who deals with structures that are out of the ordinary range. The authors, by reason of education and long experience, are both thoroughly competent to write on advanced structural design, and they have produced an excellent result.

Chapter III gives a far more comprehensive treatment of shears and moments than do the usual books on structural design of bridges and buildings, with only such mathematics as any advanced designer should know. Chapter IV treats of the customary methods of determining curvature, slope and deflection, but gives all methods of recent origin as well as the older methods. Chapter V deals with continuous and restrained beams, and ends with the Cross method of moment distribution.

In Chapter VI the noteworthy portion is that in which the Wagner theory of tension-fields is given. This theory goes beyond the non-buckling web basis of design for plate girders and appraises the stress condition when the web has buckled into corrugated form, in which condition it is still effective. The treatment is, to my knowledge, the first in structural literature in this country, aside from the translations issued by N.A.C.A. There is also an excellent treatment of torsional failure of beams, and of thin-walled cylinders.

Torsion of box beams, plates, angles, channels and tees, is fully treated in Chapter VII. Truss analysis in Chapter VIII starts with the common theory of planar trusses and goes far into three dimensional space frameworks. Bridge spans are the elementary form of such structures, which may be treated as an aggregation of planar trusses; airplane wings and airship structures are among the most complex.

Chapter X, Columns, gives much data on the local elastic failure of thin materials, and of non-symmetrical sections. Chapter XII, Deflections, is a more thorough discussion than is usual in structural books.

Vol. II covers indeterminate structures and beam-columns, in which will be found as extensive treatment of beams which are subjected to axial compression or tension in conjunction with lateral bending. It contains extensive tables.

Throughout the book both analytical and graphical methods are used, and members of varying cross section are fully treated. The general reader should recognize that the aircraft designer is forced to economize in weight wherever possible, in order that there may remain sufficient "payload" to permit operation of his aircraft, hence such a designer must use far more precision than the designer of bridges and buildings. However, some major bridge failures of the past might perhaps have been avoided had their designers been familiar with some of the refinements set forth in this book.

The book will repay study by all structural designers. *Reviewed by* W. WATTERS PAGON, *Consulting Engineer, Baltimore, Md.*

About Mathematics

MEN OF MATHEMATICS—By E. T. Bell. 592 pp. Published by Simon & Schuster, New York. Price $5.

A knowledge of mathematics is a primary equipment for an engineer. For this reason he should be interested in the men who have created mathematics. The book under review meets this interest in a remarkable degree. As the author says it is addressed to those "who may wish to see what sort of human beings the

men who created modern mathematics were".

Sir Isaac Newton stands on a mountain peak among the mathematicians whose careers are so interestingly described by the author. At one time Newton and his rival Leibnitz were friends. Later, "the most shameful squabble over priority in the history of mathematics" broke out as to who had invented the calculus. The question has been asked, "Why do students fear the calculus as children fear the dark?" The reviewer believes that if a student would read as an introduction to its study the half-dozen pages on the subject in the chapter on Newton this fear might be removed. He would at least learn what the calculus is about.

Weaknesses, foibles, dislikes, jealousies and religious beliefs of his characters are related by the author. In brief, the engineer who has not read "Men of Mathematics" has a rare pleasure awaiting him. *Reviewed by* ROBINS FLEMING, *New York.*

MISCELLANEOUS NOTES ON BOOKLETS AND REPRINTS

LAND SUBDIVISION SUGGESTIONS to aid in the planning of new developments are outlined in Planning Profitable Neighborhoods, Technical Bulletin No. 7, of the Federal Housing Administration. For sale by the Superintendent of Documents, Washington, D. C., price, 20c.

TIMELY INFORMATION concerning Fort Peck Dam is given in "Fort Peck Dam—Missouri River, Senate Committee Reprint, 75th Congress, 2nd Session", copies of which may be obtained from the Superintendent of Documents, Washington, D. C.

FLOOD WAVES were made the subject of a thesis study by Elmer E. Moots. Mr. Moots' findings have been published by the University of Iowa, Iowa City, as Bulletin 14, "Studies in Engineering".

SALARIES OF ENGINEERS in civil service in New York State are given in the Report of the Temporary Salary Standardization Board, Albany, N. Y.

USES OF ASPHALT are covered in recent bulletins of the Asphalt Institute, 801 Second Ave., New York. Included in the "Information Series" are No. 31, Trends in Use of Asphalt Products for Highways, and No. 32, Better Balance Achieved in State Highway Systems. In the Institute's "Construction Series", are papers presented at the Eleventh National Paving Conference: No. 40, Soil Stabilization With Asphalt; No. 41, Plant Mix; No. 42, a group of varied papers; No. 43, Water Control and Erosion Prevention Using Asphalt; and No. 44, Types of Asphalt Sidewalks for Country Highways.

NEW PUBLICATIONS

FORMULAS FOR STRESS AND STRAIN—By Raymond J. Roark. 326 pp. Published by McGraw-Hill Book Co., New York and London. Price $3.

STEEL CONSTRUCTION—By Henry Jackson Burt and C. H. Sandberg. 438 pp. Published by The American Technical Society, Chicago. Price $3.50

PRACTICAL SHELL DEVELOPING FOR STEEL SHIPBUILDERS—By Adam F. Tulin. 149 pp. Published by Simmons-Boardman Publishing Co., New York. Price $3.

A COURSE OF STUDY IN CHEMICAL PRINCIPLES—By Arthur A. Noyes and Miles S. Sherrill—Second Edition. 554 pp. Published by The Macmillan Co., New York. Price $5.

MECHANICS OF MATERIALS—By Philip G. Laurson and William J. Cox. 408 pp. Published by John Wiley & Sons, New York, Chapman & Hall, London. Price $3.75.

TRADE STANDARDS Adopted by Compressed Air Institute—Fifth Edition. 110 pp. Published by the institute, 90 West St., New York, N. Y. Price $1.

SANDHOG—By Borden Chase. 328 pp. Published by The Penn Publishing Co. Philadelphia. Price $2.50.

INTRODUCTORY QUANTUM MECHANICS—By Vladimir Rojansky. 544 pp. Published by Prentice-Hall, Inc., New York. Price $5.50.

TRATAMIENTO DE LAS AGUAS Y LIQUIDOS CLOACALES—576 pp. Prepared and published by Obras Sanitarias de La Nacion, Buenos Aires, Argentina.

DIRECT-CURRENT MACHINERY—By Thomas C. McFarland. 438 pp. Published by the International Textbook Co., Scranton, Pa. Price $4.

DESIGN OF WEIRS ON PERMEABLE FOUNDATIONS—By A. N. Khosla, N. K. Bose, and E. McKenzie Taylor. 178 pp. Published by the Central Board of Irrigation, Simla, India.

SOIL CORROSION AND PIPE LINE PROTECTION—By Scott Ewing. 277 pp. Published by the American Gas Association, 420 Lexington Ave., New York. Price $2.50.

APPLIED HYDRAULICS—By Herbert Addison. 2nd Edition, revised and enlarged. 435 pp. Published by John Wiley & Sons, Inc., New York. Price $5.50.

MARCH OF THE IRON MEN—A Social History of Union Through Invention—By Roger Burlingame. 500 p. Published by Charles Scribner's Sons, New York and London. Price $3.75.

CONCRETE CONSTRUCTION—A Practical Treatise on All Branches of Plain and Reinforced Concrete Construction. By Charles E. Reynolds. 510 pp. Published by Concrete Publications, Ltd., London. Price 16s. abroad.

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FROM FIELD AND OFFICE

Working problems and time-saving methods . . . Edited by Charles S. Hill

Measuring Stresses in Models

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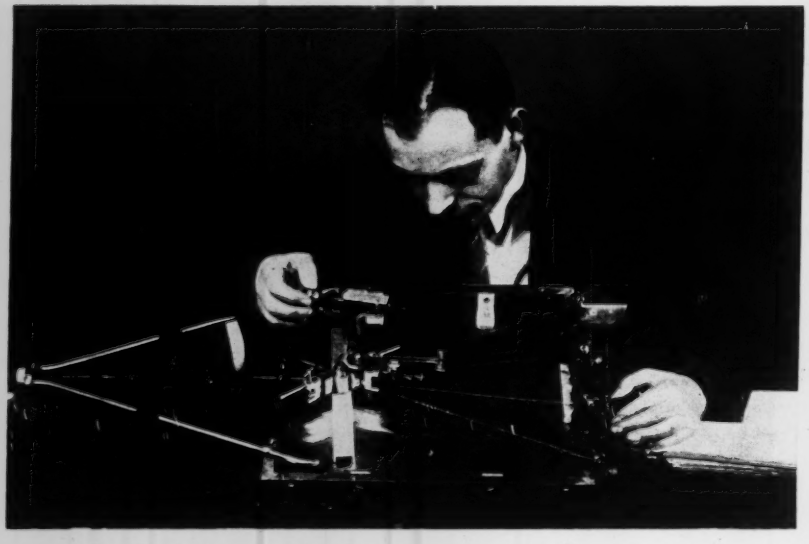
An apparatus, with which moments and stresses in structural models may be measured directly, has been developed by the writer and named the stressometer. The models are made of stock sizes of steel wire, tubes or other sections which are clamped into special joints to simulate the prototype. Fixed or moving loads are applied to the model by spring scales, and moments and stresses or reactions are read in pounds or inch-pounds on a test scale.

The operation of the apparatus is illustrated by the accompanying view, showing a model consisting of four bars hung from fixed supports (at the right) and intersecting at a common point, where they are held by one of the special joints. The load is applied by the spring scale at the left.

When it is required to find the stress in one of the members, this member is "cut" or released at the joint and then brought back to original position by the test scale (being manipulated by the operator). Before the member is "cut," a strain gage is attached across the section to be broken, and its indicator (shown extending out to the right from the special joint) is set at zero. When the member is broken the strain gage shows the movement. Then, when the test scale force is applied, the strain gage indicator moves back to zero at which time the reading on the test scale is the stress in the member.

In measuring moments, the member is similarly broken, and an opposing torque is applied by the test scale to bring the sides of the section back to angular position.

This method of determining stresses may also be used to ascertain dead load stresses in existing loaded structures which is not practicable by other methods.



Details of a new model-study apparatus known as the stressometer.

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A Non-Clog Grating

Catch basin grates with a flat top are subject to frequent clogging from leaves, paper and other debris and thus become ineffective in storm water collections. A new grate design which is said to eliminate this difficulty is shown by the accompanying illustration. The grate has large openings

A non-clogging catch basin grate

to permit the passage of debris that ordinarily causes obstruction to the flow. To secure the large openings, the design provides for a raised center section and a minimum number of ribs. This type of grate is particularly recommended for catch basin installations in parks and residential areas. The design was developed by the Utica, N. Y., engineering department which is under the direction of J. B. Shaw, city engineer.

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Bath for Automobiles

W. D. M. ALLEN
Portland Cement Association,
Chicago, Ill.

Motorists who like to speed along the salty sands of Boca Chica beach, Cameron County, Texas, find that

chassis parts may quickly rust unless something is done to take off the salt and sand. The state highway department has built a short turnout near the beach and has installed a self-washing pit for automobiles. Water for the concrete pit is piped from a nearby irrigation canal and flows continuously, keeping it free of salt. The level of the water is controlled by a float valve.

All the motorist has to do to clean his car is to drive in and out of the pit without getting out of his car.

Rigid Rolling Doors

The need for unusually rigid doors in new buildings at the Chester, Pa. plant of the Sun Shipbuilding & Drydock Co. was met by an interesting adaptation of welded interlocking channel units, such as have been used for bridge and building floors. The units consist of structural channels placed alternately up and down with welds laid along the toes of the flanges. Six rolling doors 30 ft. high and from 14 to 44 ft. wide utilize this design. In addition, in one building the roof of a railroad enclosure, 20 ft. wide and 70 ft. long, is made of the interlocking channel units arranged in a series of hinged trap doors which may be opened when materials are to be moved into the building from the railroad cars.

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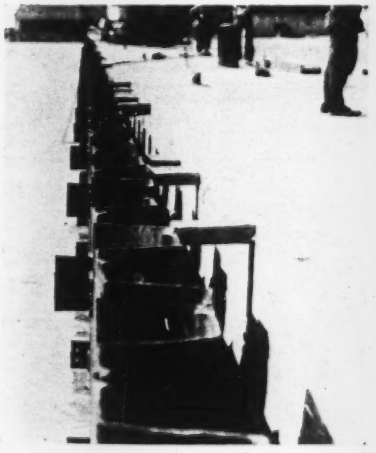
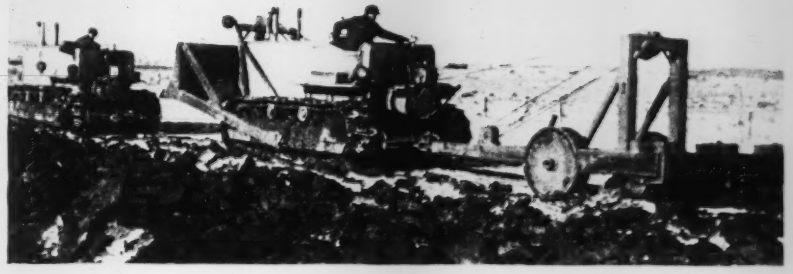
Timesaving Templet

JOHN E. FAIGLE
Civil Engineer Corps, U.S.N.,
Guantanamo Bay, Cuba

The problem of fastening fenders to a front of sheet piling came up in repairing an old marginal wharf of concrete at the Key West, Fla., naval station. Since vessels docking along the wharf will have to maneuver very slowly, the fenders consist of 10 x 10-in. creosoted timbers, 10 ft. long, hung vertically and spaced 7 ft. on centers. Each timber is supported by two pairs of clip angles welded to the face of the sheet piling. These clips were shop drilled before being welded into place; to weld the clips on the sheet piling a special device was made to space and hold each pair in its proper position. The clips were then tack-welded, and the device moved to the next set-up.



Clip angles for wharf front fenders and device for placing them.



CAMERA MEMORANDA

1. Antiquated tractor short of working speed but packing ample power operates a crane for placing 6½-ton girders on Crow Creek Bridge at Cheyenne, Wyoming. 2. Tractors in tandem hitched to a rooter tear up 16 to 20 inches of frozen soil crust into sizes for a carryall scraper on winter roadwork between Bosler and Rock River, Wyoming.

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Plotting Points for Curves

THOMAS C. COLEMAN, JR.
West Somerville, Mass.

In plotting highway plans it is often necessary to draw circular curves of large radius and of considerable length. It is seldom convenient to work from the center of the curve and frequently the length of the curve is such that the conventional curved templates cannot be used until additional points on the curve are plotted. A slide rule is a convenient and usually sufficiently accurate tool for computing the location of such additional points, but it should be used with formulas that do not require subtraction operations. The accompanying sketches indicate formulas which give such points.

In using the slide rule with these formulas the slide is turned over and inserted in the rule so that the "sine" scale operated in conjunction with the "A" scale and the "tangent" scale in conjunction with "D" scale. Multiplication by angular functions can then be performed.

In dealing with tangents of angles less than 6 deg. the sine is used. For angles of less than 30 min., the function of an even multiple of the angle can be used, and division can be made of the answer.

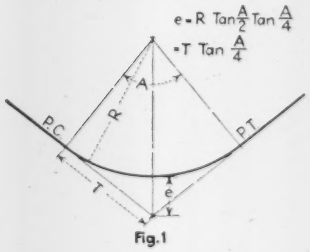

Fig. 1

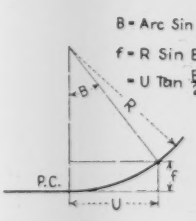

Fig. 2

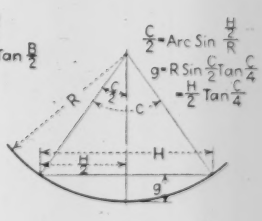

Fig. 3

CONTRACT UNIT PRICES

What contractors are bidding on different kinds of construction work

ROADS, YELLOWSTONE PARK

OWNER: U. S. Bureau of Public Roads; B. W. Matteson, acting district engineer, Denver.

PROJECT: Construction of additional base course and dense grade plant mix bituminous surfacing on 21.65 mi. of road between Tower Junction and Cooks City.

BIDS: Twelve bids were received Aug. 23, 1938, ranging from the contract low of $178,444 to $310,613.

LOW BIDDERS:

1. Max J. Kuney Co., Spokane (contract).... $178,444
2. Woodward Construction Co., Rock Springs, Wyo. 198,698
3. Olof Nelson Construction Co., Logan, Utah.. 203,744

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Maint. of exist. road and sections accepted for traffic	L.S.	$2,000.00	$2,000.00	$2,000.00
2. Clearing	L.S.	100.00	400.00	100.00
3. Uncl. excav	6,500 c. y.	1.00	1.02	.50
4. Uncl. excav. struct	1,300 c. y.	2.00	1.90	1.50
5. Overhaul	12,500 sta. y.	.04	0.45	.03
6. Obliteration, old roads	5 units	10.00	30.00	10.00
7. Fine grading, subgrade, shoulders	21 mi.	200.00	60.00	200.00
8. Local subgrade reinf	900 c. y.	.70	1.16	1.00
9. 1½-in. heavy base course	94,000 tons	.80	.70	.72
10. Watering	3,300 M g.	1.00	1.00	1.50
11. Roller operation	700 hr.	4.00	3.00	3.00
12. Furn. roller	1 ea.	500.00	400.00	300.00
13. Water plant, or plants	L.S.	100.00	100.00	100.00
14. MC–1 Cutback asph. for prime coat	99,000 gal.	.07	.0925	.095
15. Class F—dense plant mix	28,500 tons	1.30	1.90	1.98
16. MC–5 Cutback asph. cl. F.	340,000 gal.	.05	.0775	.085
17. RC–1 Cutback asph. cl. F.	45,000 gal.	.07	.0975	.095
17. RC–1 Cutback asph. cl. F.	45,000 gal.	.07	.0975	.095
18. Cl. "A" cem. stone masonry	221 c. y.	25.00	22.50	24.00
19. 24-in. C. G. S. M. pipe	162 l. f.	5.00	4.60	3.00
20. 6-in. perf. C. S. M. P. underdrain	5,000 l. f.	1.00	1.275	1.00
21. Grouted rubble gutter	70 s. y.	10.00	6.00	5.00
22. Hub-High rustic guard rail	3,680 l. f.	1.00	1.60	1.50

SANITARY SEWER, MILWAUKEE

OWNER: Metropolitan Sewerage Commission of Milwaukee; J. L. Ferebee, engineer.

PROJECT: Constructing main sanitary sewer; Contract 77, 399 ft. of 15-in. vitrified clay pipe encased in a 6-in. concrete envelope; 18 ft. of standard manhole and 31 ft. of drop manhole. Contract 79, 5,655 ft. of egg-shaped sewer encased in a concrete envelope plus pipe and manholes.

CONDITIONS: Under contract 77, stipulated contract time is two months; under contract 79, time is 12 months. Highway transportation is available. The average depth of the first sewer is 20 ft., except where it drops to 32 ft. under a railway right-of-way. Soil conditions are partly gravel and partly gray sandy stony clay. Manholes are 4 ft. inside diameter and have 9-in. concrete walls. The greatest portion of the egg-shaped sewer will be constructed in railway right-of-way along Manor Drive from S. 92nd and Mitchell St. to S. 108th St. The contractor may have to construct a roadway in order to gain access to the work. Average depth is 55 ft. Borings indicate the ground to be of gray clayey moist sand and reddish gray stoney clayey sand, indicating a compressed air job. Maximum dimensions of the egg-shaped sewer are 3 ft. 3in. inside, and outside dimensions of the rectangular envelope are 4 ft. by 4 ft. 9 in. Minimum labor rates are as follows: skilled, $1.35 per hr.; common, $1.00 per hr.

BIDS: Four bids were received on each schedule Oct. 6, 1938. On schedule 77, the range was from $14,515 to $22,509; on schedule 79, the range was from $193,624 to $211,384.

Schedule 77

LOW BIDDERS:

1. F. A. Goll Co., Milwaukee (contract)..... $14,515
2. G. R. Fehr, Inc., Milwaukee..... 16,646
3. H. Hohensee Construction Co., Wauwatosa... 17,513

Item	Quan.	Unit Prices (1)	(2)	(3)
1. 15-in. V. C. pipe, envelope	399 l. f.	$33.20	$38.65	$40.00
2. Std. manhole	18 v. f.	24.00	25.00	26.00
3. Drop manhole	31 v. f.	27.00	25.00	35.00

Schedule 79

1. G. R. Fehr, Inc., Milwaukee (contract)..... $193,624
2. Wenzel & Henoch Co., Milwaukee..... 206,791
3. F. A. Goll, Milwaukee..... 209,075

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Spl. section sewer	5,655 l. f.	$30.00	$33.30	$32.60
2. 10-in. v. c	733 l. f.	18.00	14.00	22.20
3. Std. manhole	203 v. f.	30.00	22.00	23.80
4. Drop manhole	134 v. f.	35.00	28.00	27.00

SEWAGE DISPOSAL PLANT, ALBUQUERQUE, N. M.

OWNER: City of Albuquerque; Charles E. Wells, city manager.

PROJECT: Construction of a sewage disposal plant involving a primary and secondary trickling filter plant. Construction is of tile, concrete and stucco finish. Stipulated contract time is 200 days. Transportation facilities by rail and highway are available.

BIDS: Twelve bids were received Sept. 27, 1938, ranging from $209,465 to $281,573. Minimum labor rates are as follows: skilled, $1.00 per hr.; semi-skilled, 50c. per hr.; common, 40c. per hr.

LOW BIDDERS:

1. Bradbury & Marchant, Albuquerque..... $209,465
2. Kilbourne L. House, Albuquerque..... 210,000
3. Central Contracting Co., Dallas..... 229,172

Item	Unit Prices (1)	(2)	(3)
1. Clearing, removal of structures, fence	$5,581	$4,956	$6,923
2. Structures for comminutor, parshall flume, etc	1,785	1,435	1,582
3. Building	8,159	11,028	11,888
4. Mixing basin, etc	8,794	8,295	8,261
5. Clarifier	13,986	16,390	17,885
6. Trickling filters	79,566	80,632	87,492
7. Digesters	29,529	29,814	31,120
8. Sludge drying beds	6,505	5,354	7,440
9. Piping and valves	16,069	14,326	14,560
10. Comminutors	6,536	7,053	7,227
11. Flow register	230	230	580
12. Chemical feed equipment	3,108	3,431	3,575
13. Pumps	2,352	2,148	2,462
14. Gas control equipment	1,893	808	865
15. Power unit	19,602	19,571	18,790
16. Excavation, fill, miscellaneous	5,768	4,531	8,522

(*Contract Unit Prices continued on second following page*)